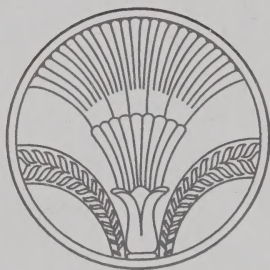


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MACOWANITES VINACEODORUS SP. NOV., (RUSSULALES) A NEW GASTEROID FUNGUS FROM COASTAL DUNES OF SPAIN

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ABSTRACT

Macowanites vinaceodorus is proposed and described as a new species, together with details on ecology, morphology, anatomy and compared with related taxa.

Key words: *Macowanites vinaceodorus*, *M. americanus*, *M. olidus*, taxonomy, ecology, Iberian Peninsula.

INTRODUCTION

Only two species of *Macowanites* have previously been described in Europe: *M. krjukowensis* (Buchholz) Singer & A. H. Sm., from Russia, under *Populus*, *Betula* and *Tilia* (BUCHHOLZ, 1901, sub *Secotium krjukowensis*), and *M. messapicoides* Llistosella & Vidal, found in Spain, under *Quercus ilex* (LLISTOSELLA & VIDAL, 1995).

The type species is *M. agaricina* Kalchbr. ex Berk., and about 25 species are known actually (SINGER & SMITH, 1960; SMITH, 1963; MOSER *et al.*, 1977; CAZARES & TRAPPE, 1991; LLISTOSELLA & VIDAL, 1995).

As a result of several visits to Portugal and Southern Spain during 1998 and 1999, we have collected three species of gasteriod *Russulales* which seem to be undescribed taxa. All have been found in littoral sand dunes, associated with *Pinus pinea*. One is being described as *M. ammophilus* (VIDAL & CALONGE, 2001), the second one is under study, and the third is being described here as *M. vinaceodorus*. For colour terminology we have followed KORNERUP & WANSCHER (1978).

DESCRIPTION

Macowanites vinaceodorus Calonge & Vidal, sp. nov. (figs. 1-3)

Etym.: *vinaceodorus*, cum odoris vini.

Diagnosis.- *Gasterocarpus gregarius*, subhypogaeus, deinde epigeus, stipitatus. Pileus 3-6(-8.5) cm latus, convexus vel plano-convexus. Peridium viscidum, pallidum, deinde purpureo-violaceus, ochraceo-maculatum, 150-250 μ m crassum, mediopellis gelatinosa, hyphis 1.25-3.75 μ m diam, cum pigmentum violaceo-roseum. Stipite-columella cylindrica, percurrentis, 1.5-2.5 (4) x 0.8-2.5 cm, albida. Rhizomorpha presentis. Gleba ochracea, sublamellar-anastomosa. Odor vinosus. Sporae globosae vel subovoideae, 8-11 x 7-9.5 μ m (9-13.5 x 8.5-12.5 μ m) asimetricae, alutaceae, tenuitunicatae, verrucosae vel subreticulatae, amyloideae. Basidia 30-45 x 11-16 μ m, late clavata, 2-4-sporigena. Macrocystidia 50-75 x 10-16 μ m, fusiformia vel utriformia, pedicellata. Trama hymenophoralis heteromera. Sphaerocystis numerosis vel 50 μ m latis.

Holotypus: Hispania, provincia Huelva, Mazagon, subter Pinus pinea, 27-XI-1999, legit F. D. Calonge et J. M. Vidal, MA-Fungi 47416. **Isotypus:** In herbaria K, PC et BPI.

Basidioma gregarius, subhypogaeus when young, epigeous at maturity, stipitate (fig.1a). Pileus 3-6 (-8.5) cm diam, convex to plano-convex and depressed, expanding, margin involute. Peridium smooth, viscid, with adherent granules of sand, initially joined to stipe but promptly separated from it, pallid at the margin, white to pinkish white (K & W 11A2), darker at the center, violet brown (K & W 11E8), usually maculated in light orange (K & W 5A4), specially at the margin. Stipe-columella percurrent, cylindrical or attenuate at base, 1.5-2.5 (-4) x 0.8-2.5 cm, with a well-developed rhizomorph, white, unchanging when bruised. Context white, initially solid, then cavernous in the stipe (fig. 1a). Gleba loculate in the upper zone, sublamellate in the lower part, initially annexed to the stipe-columella, promptly completely free and exposing the lower sublamellate chambers (fig. 1a), light orange (K & W 5A4). Spore-mass in the locules pale orange (K & W 5A3). Odour very surprising and intense, vinaceous in fresh basidiomata. It reminds the smell present in old fruits before fermentation, or in old basidiomata of certain fungi such as those of *Agrocybe aegerita*, reminding a young wine. In all cases it corresponds to aromatic substances formed as a result of fermenting processes on organic materials with glucosidic contents. Taste sweetish at first, but remotely acid after a few minutes. Chemical reactions are like in *Russula*, flesh changes to pink when contacting FeSO₄, but does not change in the presence of other reagents such as guayac, NH₃, phenol and KOH.

Spores 7-11 x 6-9.5 μ m (9-13.5 x 8.5 - 12.5 μ m) ornamentation included, globose to broadly ellipsoid (figs. 2-3), heterotropic, with an hilar appendage. Amyloid ornamentation consisting of isolated warts, crests of a subreticulum, being 0.7-1.5 μ m high, with a suprahilar plage (figs. 1b-c). Basidia broadly claviform, hyaline in 5% KOH, 30-45 x 11-16 μ m, fusiform to utriform, acute, and long pedicellate. Subhimenium cellular. Hymenophoral trama heteromorous, with large sphaerocysts up to 50 μ m diam. Context of pileus and stipe-columella typically heteromorous. Peridiopellis thin, 150-250 μ m. Suprapellis an intricate trichodermis of redressed hyphae and dermatopseudocystidia 30-75 x 2.5-11 μ m, cylindrical to claviform. Mediopellis an intricate isocutis made of gelatinized repent hyphae, 1.25-3.75 μ m diam, with intracellular violet pinkish pigment. Oleiferous hyphae present. Subpellis an intricate cutis of non-gelatinized hyphae, 2-6 μ m diam. Stipitipellis a cutis of repent hyphae, 2-6 μ m diam, with some redressed hyphae and dermatopseudocystidia like those of the peridiopellis.

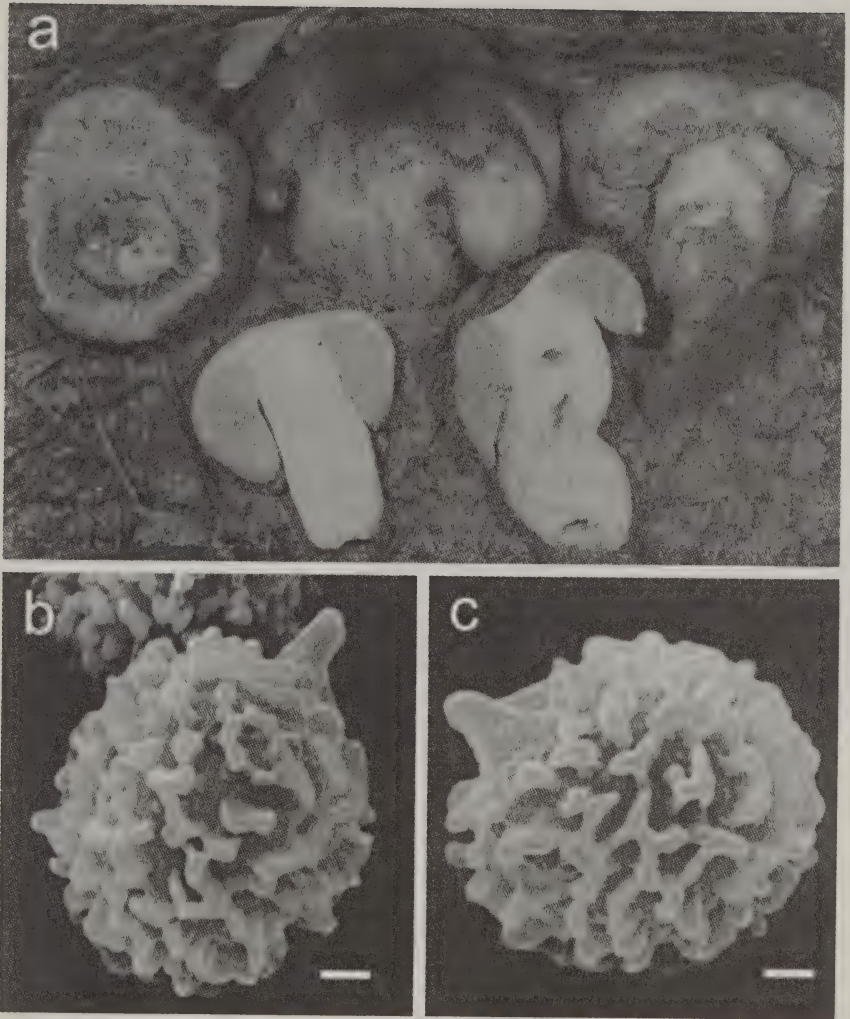


Fig. 1-- *Macowanites vinaceodorus* (a-c). a: Several gasterocarps in their natural habitat showing the main characters (MA-Fungi 47416, Holotype). b-c: Spores as seen under the SEM. Observe the ornamentation mainly warty (MA-Fungi 47416, Holotype).

Holotypus: Spain, Huelva province, Mazagón, abundant fruitbodies were collected growing in littoral sand dunes under *Pinus pinea*, at the vicinity of different plants, such as *Corema*, *Halimium*, *Helichrysum*, etc., 27-XI-1999, leg. F. D. Calonge & J. M. Vidal, MA-Fungi 47416. **Isotypus:** In herbaria K, PC and BPI.

DISCUSSION

When first observed this fungus in its natural habitat it looks very much like a typical *Russula*, being a species rather alike *Russula cessans*, for instance. However, this feeling changes after examining the anastomosed lamellar gleba. It is clear the evolutionary transit between the typical epigeous forms of *Russula* to the subhypogeous *Macowanites*. Regarding the orange colour of the gleba and the globose, verrucose to subreticulated, ochraceous coloured spores, and the habitat under conifers, there are several species with similar characters, all them in North and Central America, in alpine and subalpine forests. The most similar species is *M. americanus* Singer & A.H. Sm.(figs. 2 a-b), which presents almost the same microscopy and colour of the pileus, but with frequent olive tones, which are absent in our material. On the other hand, the size is smaller, 1-5 cm diam of the pileous and lacks of any distinctive smell, being associated to *Abies*, *Picea* and *Pseudotsuga*. It grows in mountainous areas of the Pacific Norwest (SINGER & SMITH, 1960). Another North American similar species is *M. olidus* Smith, with pinkish cinnamon peridium, tinged with olive over the disc, showing an aromatic odour reminding that of *Russula laurocerasi* (SMITH, 1963), and the spores mostly subreticulate (figs. 2 c-d).

Macowanites mexicanus Guzmán, differs by the reddish to coffee-reddish peridium and orange-yellowish stipe. The dermatocystidia and the macrocystidia are also different, without any noticeable smell and grows under *Pinus oocarpa* and *P. montezumae*, up to 3000 m altitude in Mexico (GUZMÁN, 1988). In a recent revision of the type material of *M. mexicanus* HERNÁNDEZ-HERRERA & KONG-LUZ (1998) considered that this taxon was identical to *Cystangium pineti* Singer. However, after the revision of the type material, kindly sent by Dr. G. Guzmán, under the herbarium number XAL. 19492, we think that it really belongs to the genus *Macowanites*, since it shows a filamentous pileopellis.

Regarding *M. vinaceodorus*, there is only one species with the same smell of wine, *M. lymanensis* Cazares & Trappe, but this species presents a reduced stipe, being angiocarpic, with loculate gleba, dull yellowish peridium with brownish tinges on the disc, pallid in the margin, without violaceous tones, macrocystidia absent. It grows under *Abies*, at 1700 m (CAZARES & TRAPPE, 1991).

As a matter of fact, *M. vinaceodorus* shows a combination of characters, such as smell of wine, larger size, pinkish to violet brownish peridium, sublamellate, light orange gleba, basal rhizomorphs and habitat in littoral sand dunes under *Pinus pinea*, which confer this taxon enough identity to be proposed as a new species.

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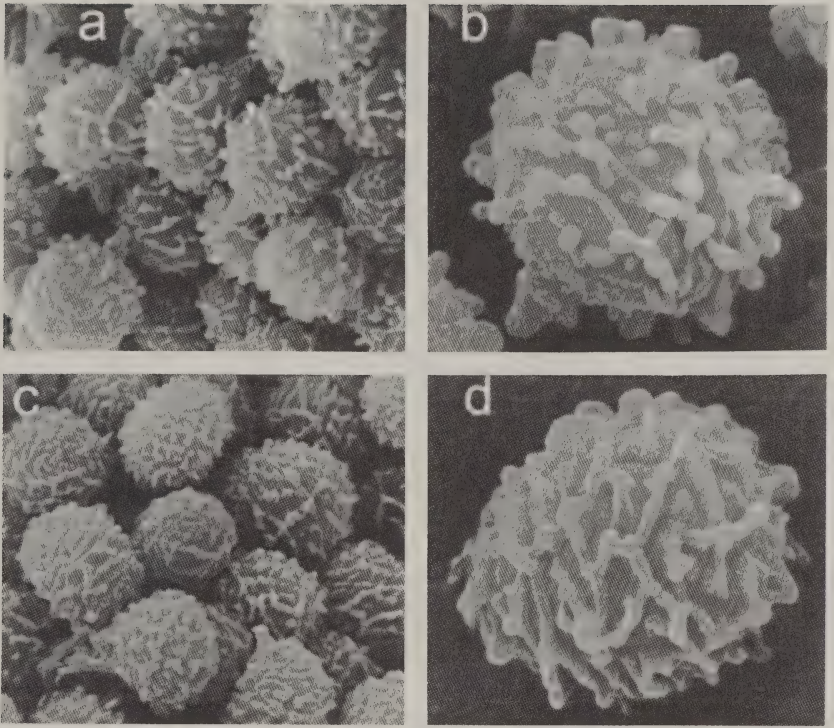


Fig. 2- **a-b:** *Macowanites americanus*. Spores observed under the SEM showing an ornamentation from warty to subreticulate (MICH 45032, Holotype). **c-d:** *Macowanites olidus*. Spores observed under the SEM showing an ornamentation mostly subreticulate (MICH 65876, Holotype).

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PHYLOGENETIC RELATIONSHIPS OF PANELLUS (AGARICALES) AND RELATED SPECIES BASED ON MORPHOLOGY AND RIBOSOMAL LARGE SUBUNIT DNA SEQUENCESJiankang Jin, Karen W. Hughes¹ & Ronald H. Petersen

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Abstract: *Panellus*, *sensu lato* has included putatively related taxa with uncertain affinities. Previous researchers suggested that *Dictyopanus*, a poroid mushroom, was closely related to the gilled *Panellus*, but affinities of *Dictyopanus* and *Panellus* to segregate genera of *Tectella*, *Pleurotopsis* and *Sarcomyxa* remained uncertain. Representative specimens and isolates of eight species of *Panellus s.l.* and *Dictyopanus* were examined; *P. stypticus*, *P. mitis*, *P. ringens*, *P. violaceofulvus*, *P. serotinus*, *P. patellaris*, *P. longinquus* and *Dictyopanus pusillus*. Phylogenies based on morphology and ribosomal large subunit DNA sequences were constructed. Both methods supported five clades: 1) *D. pusillus* and *P. stypticus*; 2) *P. ringens* and *P. violaceofulvus*; 3) *P. mitis*; 4) *P. serotinus*; and 5) *P. patellaris*. Inclusion of sequences for *Resinomyces acadensis*, *Mycena rutilanthiformis* and *M. clavicularis* showed that *Panellus s.l.* was polyphyletic. Generic designations exist for all clades or terminal taxa except for *Panellus mitis* which may require new generic placement. Both *P. stypticus* and *D. pusillus* share a homologous Group I Intron at the same position of the ribosomal large subunit gene, further supporting a close relationship between *Dictyopanus* and *Panellus*.

Key words: *Dictyopanus*, *Pleurotopsis*, Ribosomal Large Subunit RNA, *Sarcomyxa*, *Tectella*

INTRODUCTION

The genus name *Panellus* was proposed by Karsten (1879) with the type species, *P. stypticus* (Bull. Fr.) Karst. Two species, *P. stypticus* and *P. farinaceus* (Schum.) Karsten, were originally included in the genus (Karsten, 1879). Murrill (1915) listed 10 species in this genus, *P. stypticus*, *P. jalapensis* Murrill, *P. cantharelloides* Montagne, *P. subcantharelloides* Murrill, *P. flabellatus* Murrill, *P. eugrammus* (Mont.) Murrill, *P. dealbatus* (Berk.) Murrill, *P. haematopus* (Berk.) Murrill, *P. ursinus* (Fries) Murrill and *P. vulpinus* (Sow.) Murrill; but most of these were subsequently transferred to other genera. Smith (1949) included two genera, *Panellus* and *Tectella*, under Tricholomataceae, subfamily Pleurotoideae, but Kühner and Romagnesi (1953) included *P. (Tectella) patellaris* (Fr.) Earle within *Panellus* together with *P. serotinus* (Fr. ex Schrad.) Kühner, *P. mitis* (Fr.) Kühner, *P. ringens*

(Fr) Romagnesi, *P. violaceofulvus* (Batsch ex Fr.) Singer, and *P. stypticus*. The Kühner-Romagnesi scheme is still widely used by present-day researchers including Miller (1970, 1984) who characterized the genus as having a trama of thick-walled hyphae, even gill edges, a sessile or short-stipitate basidiocarp, cheilocystidia, lignicolous habitat, and white, smooth, amyloid, allantoid to narrowly elliptical spores. Spore characters easily separate *Panellus* from other "pleurotoid" genera including *Pleurotus*, *Panus*, *Cheimonophyllum*, *Pleurocybella*, *Hohenbuehelia* and *Resupinatus* (Miller, 1984).

Burdsall and Miller (1975) proposed merging the poroid *Dictyopanus* into *Panellus*, based on similarities spore shape, well-developed stipe and ability of basidiomata to revive when moistened, and proposed two subgenera under *Panellus*, *Panellus* and *Mitellus*. The former included *P. stypticus*, *P. pusillus* (Pers. ex Lev.) Burdsall & Miller and *P. copelandii* (Pat.) Burdsall & Miller. The latter included *P. mitis*, *P. patellaris* (Fr.) Konrad & Maublanc, *P. serotinus*, *P. ringens*, and *P. violaceofulvus*. Later, Burdsall and Miller (1978) transferred *D. orientalis* Koboyasi to *Panellus* as *P. orientalis*, with two varieties, *D. pusillus* var. *pseudorhipidium* and *D. p.* var. *sublamellatus*. Since *D. pusillus* (Pers. Ex Lev.) Singer is the type species of *Dictyopanus*, the new combination reflected the merger of *Dictyopanus* into *Panellus*. Corner (1986), in agreement with Burdsall and Miller (1978) treated *Dictyopanus* as a synonym of *Panellus* and incorporated 22 new poroid and lamellate species reported from Malaysia. In his wide circumscription of the genus, *Panellus longinquus* (Berk.) Sing. was tentatively placed in this genus. Singer (1975, 1986) however, separated *Panellus* and *Dictyopanus*, which together with *Tectella* were placed in the Tricholomataceae tribus Panelleae. For Singer, *Panellus* contained two subgenera, *Panellus* and *Serotinae*. Singer's arrangement is also widely used today.

Recently, phylogenetic analyses based on 18S nuclear ribosomal DNA (nuc-SSU) and mitochondrial ribosomal small subunit (mit-SSU) sequences of homobasidiomycetes have shown that *P. stypticus* was closely related to *P. serotinus* (Hibbett 1996, Hibbett et al 1997), but a single most parsimonious tree based on mitochondrial rDNA placed *P. stypticus* and *P. serotinus* in different clades (Hibbett and Donoghue 1995).

In this study, we have examined relationships among eight species within this complex: *Panellus stypticus*, *P. mitis*, *P. ringens*, *P. serotinus*, *P. violaceofulvus*, *P. patellaris*, *P. longinquus* and *D. pusillus*, based on morphology and nuclear ribosomal large subunit (nLSU) DNA sequences.

METHODS AND MATERIALS

Collections: Collections used in this study are listed in Table 1. CBS391.50 (*P. violaceofulvus*) was represented by a culture only. Cultures were obtained and maintained as discussed by Hughes et al. (1999).

Morphological examination: Exemplars from each species in the genus complex were selected for morphological examination. For microscopic characters, a basidioma was supported in *Sambucus* pith, and sectioned under a dissecting

microscope at a magnification of 10 X or 20 X. Some microscopic characters were observed at 10 X or 20 X magnification. Other micro-characters were observed with a Wild compound microscope at a magnification of 187- 1875 X (oil immersion). Measurements were aided by an ocular micrometer, calibrated with a haemocytometer grid.

Table 1. Collections examined

Collection	TENN Accession No.	GenBank Accession Number	Species	Country	Location	Host
2675	48833	(AY014292)	<i>Panellus stypticus</i>	New Zealand	Fjordland	<i>Nothofagus</i>
3342	48835		<i>Panellus stypticus</i>	Russia	Primorsk	rotten <i>Quercus</i>
4319	50398		<i>Panellus stypticus</i>	Switzerland	Maggia	rotting <i>Abies</i>
6157	52316		<i>Panellus stypticus</i>	USA	TN, Polk Co.	na
8265	54317	(AY014291)	<i>Dictyopanus pusillus</i>	USA	FL, Ocala Nat Forest	hardwood
9408	56382		<i>Dictyopanus pusillus</i>	Costa Rica	Prov. Alajuela	hardwood
9522	56278		<i>Dictyopanus pusillus</i>	USA	FL	oak or cypress
9803	56342		<i>Dictyopanus pusillus</i>	Puerto Rico	El Yunque	deciduous trunk
9808	56347		<i>Dictyopanus pusillus</i>	Puerto Rico	El Yunque	rotten log
5644	52389	(AY014288)	<i>Panellus mitis</i>	USA	ID, Bonner Co.	conifer twig
7486	53512		<i>Panellus mitis</i>	Finland	Etelä-häme Prov.	<i>Pinus</i> bark
7494	53511		<i>Panellus mitis</i>	Finland	Etelä-häme Prov.	<i>Picea</i> bark
6881	53461	(AY014287)	<i>Panellus serotinus</i>	USA	NY, Schuyler Co.	na
6894	53450		<i>Panellus serotinus</i>	USA	NC, Macon Co	yellow birch
9992	58324		<i>Panellus serotinus</i>	USA	NC, Macon Co.	na
6711	52365	(AY014290)	<i>Panellus ringens</i>	USA	AK, Tumagain Arm	hardwood
9812	58308	(AF325361)	<i>Panellus ringens</i>	USA	NC, Graham Co.	unknown bark
CBS391.50 (culture only)			<i>Panellus violaceofulvus</i>	France	na	na
DAOM 198753	58323		<i>Panellus violaceofulvus</i>	Canada	Quebec, Forillon Nat. Park	fir branch
6170	52302	(AF014286)	<i>Panellus patellaris</i>	USA	NC, Macon Co.	hardwood
6486	53403		<i>Panellus patellaris</i>	USA	NY, Dutchess Co.	hardwood
6662	53214	(AF014289)	<i>Panellus longinquus</i>	USA	WA, Callam Co.	alder
6663	53215		<i>Panellus longinquus</i>	USA	WA, Grey's Harbor	unknown

Morphological analyses: Macroscopic and microscopic morphocharacters from Table 2 and Table 3, together with host substrates from which collections were obtained were incorporated into a data matrix (Table 4). In Table 4, characters are defined as follows: 1. A. lamellate, B. poroid; 2. A. panelloid, B. pleurotoid but not panelloid, C. pendent / bell-shaped; [“panelloid” is a descriptive term for basidioma stature as defined by Corner (1986). In this study, panelloid refers to a basidioma with a short conspicuous lateral stipe, which is concolorous or slightly different from the pileus, and clearly is not part of the pileus. Lamellate or poroid hymenia emerge above the stipe and the pileus is typically dimidiate.] 3. A. membranous veil absent, B. membranous veil present; 4. A. basidioma substipitate, B. basidioma sessile or pseudostipitate; 5. A. pileus surface pubescence absent, B. pileus surface pubescence present; 6. A. lamellae crowded, B. lamellae dense, C. lamellae subdistant to distant; 7. A. lamellae not equal length, B. equal length; 8. A. lamellae not forked, B. lamellae forked; 9. A. basidiomata revivable, B. basidiomata not revivable; 10. hymenium length A. <10 µm, B. 10- 20 µm, C. > 20 µm; 11. A. pleurocystidia thin-walled, B. pleurocystidia thick-walled; 12. A. extension of

Table 2. Macroscopic morphocharacters of exemplars in the *Panellus* complex¹

Field no.	TENN accession no.	species	hymenium	basidioma stature	stipe	Membranous veil	pileus pubescence	lamellae density	lamellae equal length	lamellae forked
2675	48833	<i>P. stypticus</i>	lamellate	panelloid	substipitate	no	no	close	no	no
3342	48835	<i>P. stypticus</i>	lamellate	panelloid	substipitate	no	no	close	no	no
4319	50398	<i>P. stypticus</i>	lamellate	panelloid	substipitate	no	no	close	no	no
6157	52316	<i>P. stypticus</i>	lamellate	panelloid	substipitate	no	no	close	no	no
8265	54317	<i>D. pusillus</i>	poroid	panelloid	substipitate	no	no	na	na	na
9408	56382	<i>D. pusillus</i>	poroid	panelloid	substipitate	no	no	na	na	na
9522	56278	<i>D. pusillus</i>	poroid	panelloid	substipitate	no	no	na	na	na
9803	56342	<i>D. pusillus</i>	poroid	panelloid	substipitate	no	no	na	na	na
9808	56347	<i>D. pusillus</i>	poroid	panelloid	substipitate	no	no	na	na	na
5644	52389	<i>P. mitis</i>	lamellate	substipitate	substipitate	no	no	distant	no	no
7486	53512	<i>P. mitis</i>	lamellate	pleurotoid	substipitate	no	no	distant	no	no
7494	53511	<i>P. mitis</i>	lamellate	pleurotoid	substipitate	no	no	distant	no	no
6894	53450	<i>P. serotinus</i>	lamellate	pleurotoid	substipitate	no	no	crowded	yes	no
9992	58324	<i>P. serotinus</i>	lamellate	pleurotoid	substipitate	no	no	crowded	yes	no
6711	52365	<i>P. ringens</i>	lamellate	Bell-shaped	sessile, pseudostipitate	no	yes	substant	no	no
9812	58308	<i>P. ringens</i>	lamellate	Bell-shaped	sessile, pseudostipitate	no	yes	substant	no	no
DAOM 198753	58323	<i>P. violaceofulvus</i>	lamellate	Bell-shaped	sessile	no	yes	distant	no	no
6170	52302	<i>P. patellaris</i>	lamellate	pendent	sessile, pseudostipitate	yes	yes	dense	no	no
6486	53403	<i>P. patellaris</i>	lamellate	pendent	sessile, pseudostipitate	yes	yes	dense	no	no
6662	53214	<i>P. longinquus</i>	lamellate	pleurotoid	sessile, pseudostipitate	no	no	distant	no	yes
6663	53215	<i>P. longinquus</i>	lamellate	pleurotoid	sessile, pseudostipitate	no	no	distant	no	yes

¹ na = not available

Table 3. Microscopic morphocharacters of exemplars in the genus *Panellus* complex

Field no.	TENN Accession Number	species	hymenium		pleurocystidia		chalcocystidia		spore	
			average length μm	shape	extension μm^1	shape	extension μm^1	shape	average size μm	surface
2675	48833	<i>P. stypticus</i>	25.6	clavate	3.3-17.2	clavate	16.4-41.0	allantoid	3.62x2.17	smooth
3342	48835	<i>P. stypticus</i>	23.6	clavate	9.8-17.2	clavate	16.4-24.6	allantoid	3.61x1.62	smooth
4319	50398	<i>P. stypticus</i>	15.0	clavate	16.4-20.5	clavate, ventricose	9.8-24.6	allantoid	3.54x1.89	smooth
6157	52316	<i>P. stypticus</i>	16.4	clavate	12.5-16.4	irregular clavate	28.7-41.0	allantoid	3.80x1.86	smooth
8265	54317	<i>D. pusillus</i>	6.4	clavate	16.4-23.0	clavate, dendritic	18.0	phaeosoliform	4.04x2.03	smooth
9408	56382	<i>D. pusillus</i>	6.2	clavate	12.3-16.4	clavate, dendritic	16.4-24.6	elliptical	3.46x2.33	smooth
9522	56278	<i>D. pusillus</i>	6.2	clavate	9.8-13.94	clavate, dendritic	9.8-20.5	phaeosoliform	3.78x1.86	smooth
9803	56342	<i>D. pusillus</i>	6.8	clavate	15.6-29.5	clavate, dendritic	28.7-49.2	subglobose	3.49x2.52	smooth
9808	56347	<i>D. pusillus</i>	5.7	clavate	14.8-23.8	clavate, dendritic	24.6-41.0	subglobose	3.44x2.54	smooth
5644	52389	<i>P. mitis</i>	8.0	clavate	3.3-4.1	absent or pseudocystidia	na	long cylindrical	4.43x1.61	smooth, dark amyloid
7486	53512	<i>P. mitis</i>	10.3	clavate	3.3-5.7	absent or pseudocystidia	na	na	na	na
7494	53511	<i>P. mitis</i>	6.2	clavate	4.9-6.6	absent or pseudocystidia	na	long cylindrical	4.50x1.67	smooth, dark amyloid
6894	53450	<i>P. serotinus</i>	7.8	absent	na	clavate	6.6	long cylindrical	4.64x1.46	smooth, dark amyloid
9992	58324	<i>P. serotinus</i>	5.5	minutoid, thick-walled	12.3	clavate	12.3	long cylindrical	4.18x1.42	dark amyloid,
6711	52365	<i>P. ringens</i>	8.2	clavate, thick-walled	3.3-6.6	clavate, thick-walled	4.1-5.7	cylindrical	4.58x1.89	amyloid
9812	58308	<i>P. ringens</i>	8.2	clavate, thick-walled	2.5-3.3	clavate	3.3-4.1	na	na	na
DAOM 198753	58323	<i>P. violaceofulvus</i>	25.6	clavate, thick-walled	2.5-4.1	clavate, thick-walled	4.1-5.7	allantoid	5.57x2.56	amyloid
6170	52302	<i>T. patellaris</i>	7.0	clavate, cylindrical thick-walled	13.1-13.9	clavate, thick-walled	13.9-17.2	long cylindrical	3.39x1.01	smooth, dark amyloid
6486	53403	<i>T. patellaris</i>	7.8	clavate, thick-walled	3.3-6.6	clavate, thick-walled	9.8-12.3	long cylindrical	3.97x1.50	smooth, dark amyloid
6662	53214	<i>P. longinquus</i>	23.6	clavate	2.5-4.1	clavate	2.5-4.1	phaeosoliform, thick-walled	6.79x3.54	amyloid
6663	53215	<i>P. longinquus</i>	23.6	clavate	5.7-6.6	clavate	4.1 or absent	phaeosoliform, thick-walled	5.37x3.14	amyloid

¹Extension beyond hymenium: hymenium length not included; na = not available.

Table 4. Morphology data matrix for parsimony analysis in *Panellus* complex¹

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2675	<i>P. stypticus</i>	A	A	A	A	B	A	A	A	C	A	A	A	A	A	A	A	A	A	A
3342	<i>P. stypticus</i>	A	A	A	A	B	A	A	A	C	A	A	A	A	A	A	A	A	A	A
4319	<i>P. stypticus</i>	A	A	A	A	B	A	A	A	B	A	A	A	A	A	A	A	A	A	A
6517	<i>P. stypticus</i>	A	A	A	A	B	A	A	A	B	A	A	A	A	A	A	A	A	A	na
8265	<i>D. pusillus</i>	B	A	A	A	A	na	na	A	A	A	A	A	B	A	A	A	A	A	A
9408	<i>D. pusillus</i>	B	A	A	A	A	na	na	A	A	A	A	A	B	A	A	A	A	A	A
9522	<i>D. pusillus</i>	B	A	A	A	A	na	na	A	A	A	A	A	B	A	A	A	A	A	A
9803	<i>D. pusillus</i>	B	A	A	A	A	na	na	A	A	A	A	A	B	A	A	A	A	A	A
9808	<i>D. pusillus</i>	B	A	A	A	A	na	na	A	A	A	A	A	B	A	A	A	A	A	na
5644	<i>P. mitis</i>	A	B	A	A	A	C	A	A	A	A	B	B	A	na	na	B	A	B	B
7486	<i>P. mitis</i>	A	B	A	A	A	C	A	A	B	A	B	B	A	na	na	na	na	na	B
7494	<i>P. mitis</i>	A	B	A	A	A	C	A	A	A	A	B	B	A	na	na	B	A	B	B
6894	<i>P. serotinus</i>	A	B	B	A	A	A	B	A	B	A	na	A	A	A	A	B	A	B	A
9992	<i>P. serotinus</i>	A	B	B	A	A	A	B	A	B	A	B	A	A	A	A	A	B	A	na
6711	<i>P. ringens</i>	A	C	B	A	B	C	A	A	A	B	B	A	A	A	A	B	A	A	A
9812	<i>P. ringens</i>	A	C	B	A	B	C	A	A	A	B	B	A	A	A	A	B	na	na	na
DAOM 198753	<i>P. violaceofulvus</i>	A	C	B	A	B	C	A	A	C	B	B	A	A	B	B	A	A	A	B
6170	<i>P. patellaris</i>	A	C	B	B	B	A	A	A	A	B	A	A	A	A	B	A	B	A	A
6486	<i>P. patellaris</i>	A	C	B	B	B	A	A	A	A	B	B	A	A	A	B	A	B	A	A
6662	<i>P. longinquus</i>	A	B	A	A	A	C	A	B	A	C	A	B	A	A	A	B	A	B	A
6663	<i>P. longinquus</i>	A	B	A	A	A	C	A	B	A	C	A	B	A	A	A	B	A	B	A

¹Character numbers correspond to the those given in the text; na = not available

pleurocystidia beyond the hymenium $>10\ \mu\text{m}$; B. extension of pleurocystidia beyond the hymenium $<10\ \mu\text{m}$; 13. A. cheilocystidia present, B. cheilocystidia absent or pseudocystidiate; 14. A. dendritic cheilocystidia absent, B. dendritic cheilocystidia present; 15. A. cheilocystidia thin-walled, B. cheilocystidia thick-walled; 16. A. extension of cheilocystidia beyond the hymenium $>10\ \mu\text{m}$, B. extension of cheilocystidia beyond the hymenium $<10\ \mu\text{m}$; 17. A. spores allantoid to phaseoliform, B. spores cylindrical; 18. A. spores thin-walled, B. spores thick-walled; 19. A. spores amyloid, B. spores strongly amyloid; 20. A. host hardwood or other, but not conifer, B. host conifer. Morphological characters were analyzed by parsimony analysis in PAUP, version 4.0 (Swofford 1996) using a branch and bound search. Characters were assumed to be independent. Characters that were not available were treated as missing data and as a fifth character in separate analyses. Bootstrap support was estimated by 100 bootstrap replicates. Trees were examined and manipulated using TreeView (Page 1996).

Molecular techniques and analysis: Techniques for DNA extraction and DNA sequencing were described by Hughes et al. (1999). For this study, the 5'-end of the ribosomal LSU gene was amplified for sequencing and intron detection using primers ITS3 and LR5 (White et al 1990; Vilgalys and Sun 1994). Cycle parameters for PCR amplification were: 94 C for 3 min followed by 35 repetitions of 94 C for 0.5 min, 50 C for 1 min, and 72 C for 1.5 min. The final cycle was an extension at 72 C for 3 min. If DNA had been frozen for a long time, it was pre-heated in the PCR reaction mixture at 94 C for 4 min before adding *Taq* polymerase which enhanced amplification. PCR products were verified by gel electrophoresis. For sequencing, the PCR product was purified in a 1.5% low-melt agarose gel (NuSieve GTG Agarose, FMC Bioproducts). The desired band was excised and purified with a Promega Wizard PCR Purification Kit following manufacturer's directions. Sequencing was carried out on an ABI 373 DNA sequencer (ABI Prism Dye Terminator Cycle, Perkin-Elmer Inc.) with primers ITS3, LR5, LR21 (White et al 1990; Vilgalys and Sun 1994), and NuDNA5'-371 (AAAAGAACTTTGGAAAGAGAGT). GCG (Genetics Computing Group, 1997) programs were used for sequence editing and alignment. Sequences were deposited in GenBank (Table 1).

A BLAST search of GenBank using sequences from this study identified the closest outgroup to *P. stypticus* (exemplar 4319) and *D. pusillus* (exemplar 8265) as *Resinomyces acadensis* AF042638 (Moncalvo et al, 2000). Other closely matching sequences were: *Pleurotopsis longinqua*, RV95/47, AF042604 (Moncalvo et al., 2000); *Mycena clavicularis*, RV87/6, AF042637 (Moncalvo et al, 2000); *Mycena galericulata*, RV87/14.01, AF042636 (Moncalvo et al, 2000); *Mycena rutilanthiformis*, JM96/26, AF042606 (Moncalvo et al, 2000); and *Hygrocybe citrinopallida*, 930731-1, U66435 (Lutzoni, 1997).

Group I intron sequences were removed from *P. stypticus* 4319 and *D. pusillus* 8265 and the remaining LSU sequences were aligned in SeqLab (Genetics Computing Group, 1997). Parsimony analysis using the branch and bound search option as implemented in PAUP 4.0 was used to evaluate relationships between taxa. Gaps were treated as missing data and as a fifth character in separate analyses. Bootstrap support was estimated by 100 bootstrap replicates. Phylograms were displayed in TreeView (Page 1996). The presence of a Group I intron in the nLSU

gene was inferred by length differences of PCR products on a 1.5% agarose gel and confirmed for selected collections by sequencing (Jin 2000).

RESULTS

Morphological comparisons and phylogeny reconstruction: Macroscopically, basidioma stature of *Panellus stypticus* and *Dictyopanus pusillus* could be best described as panelloid. *Panellus mitis* is unique in that it fruits always on coniferous hosts, and basidiomata exhibit a large hymenium-free area near the point of attachment. *Panellus serotinus* basidiomata are substipitate, and it is the only species with crowded lamellae of almost equal length. Lamellae are ochre-orange, smooth, and deep with entire margins. With thick flesh, basidiomata *P. serotinus* are not revivable, unlike other members of this complex. Basidiomata of *P. ringens*, *P. violaceofulvus* and *P. patellaris* are sessile or pseudostipitate. In *P. ringens*, basidiomata are violaceous or lilac, lamellae are subdistant, dark purple or violaceous, and occasional anastomoses could be observed between lamellae. The pileus is covered with fluffy pubescence. Basidiomata of *P. violaceofulvus* are small (Burdshall and Miller, 1975); (diameter for DAOM198753 mature basidiomata is 2.5–4.5 mm). Pileus color is fawn to cinnamon colored. The inner side of pileus is pale. All other characters resembled those of *P. ringens*, though the spores of exemplar collection DAOM198753 (*P. violaceofulvus*) are a little larger than those of *P. ringens* exemplar 6711. Distinctive characters for *P. patellaris* are the presence of an evanescent membrane covering lamellae in young basidiomata, rubbery-gelatinous consistency of pileus tissue, and a pubescent pileus surface. Basidiomata of *P. longinquus* is pleurotoid with decurrent lamellae, a gelatinous epicutis, and forked lamellae which are unique in this genus complex. Dried specimens of all species except *P. serotinus* rehydrated with wet paper towels for several hours to overnight. The whole basidioma of *P. mitis* becomes very gelatinous when rehydrated. Uniquely, when basidiomata of *P. longinquus* are rehydrated and revived, they turn to greenish black color.

Panellus stypticus spores are somewhat allantoid, with a relatively weak amyloid reaction. Cystidia contained or are associated with apparently excreted "oil" droplets. In *D. pusillus*, similar oil droplets are observed within and associated with cystidia. Dendritic cheilocystidia, densely packed at lamella margins, together with relative short embedded clavate cheilocystidia (gloeocystidia) (Corner 1986) are present in both species. In *P. mitis*, lamella margins are characteristic in that interior hyphae become divergent and gelatinous, forming a swollen margin in which divergent hymenial hyphae formed. Cheilocystidia are absent. In *P. serotinus*, basidiomata of one collection have thick-walled, stout, metalloid pleurocystidia, and the other collection lacks pleurocystidia. In *P. ringens*, pleurocystidia are short, clavate and thick-walled; cheilocystidia are inconspicuous and difficult to find. Extended clavate hymenial cells are present. In one collection of *P. ringens*, no spores were found, consistent with Miller's (1970) observation that spores in this species are sparse. In *P. violaceofulvus*, both pleurocystidia and cheilocystidia are short, clavate and thick-walled: spores are allantoid, phaseoliform. In exemplar collection DAOM198753 ($M = 5.57 \times 2.56 \mu\text{m}$), spores are a little bigger than those of *P. ringens* exemplar 6711 ($M = 4.58 \times 1.89 \mu\text{m}$). In *P. patellaris*, both

pleurocystidia and cheilocystidia are conspicuously clavate and thick-walled. In *P. longinquus*, spores are large ($M = 5.37\text{--}6.76 \times 3.14\text{--}3.54 \mu\text{m}$) and thick-walled.

Forty-six most parsimonious trees were obtained from analysis of morphological characters treating gaps as a fifth character. There was no difference in topology when gaps were treated as missing data. A 50% majority consensus tree is shown in Fig. 1. Unexpectedly, *Panellus ringens* and *P. violaceofulvus* grouped together. *Panellus stypticus* and *D. pusillus* formed a well-supported clade. Remaining taxa formed separate clades.

The Ribosomal LSU Group I intron: Electrophoresis of nLSU PCR products showed that DNA fragments for *P. stypticus* and *D. pusillus* were longer than those for the other six species (Jin, 2000). When sequences of *P. stypticus* [collections 4319 (Maggia, Switzerland) and 3541 (New South Wales, Australia)] and *D. pusillus* [collection 8265 (FL, USA)] were aligned with sequences of other species in this study, a ca 400 bp insertion was found, at a position corresponding to yeast LSU base 931 (Bayev et al 1981). The insertion was identified as a Group I intron by homology to Group I intron sequences in GenBank. The *P. stypticus* collection 4319 intron was 67.95% homologous to a Group I intron identified in a *P. stypticus* ribosomal SSU sequence (GenBank No. PSU59090; Hibbett 1996). In contrast, *P. stypticus* collections 4319 (Switzerland) and 3541 (Australia) introns were 97% homologous, and *P. stypticus* introns were 83–84% homologous to the *D. pusillus* intron.

The nLSU fragment length was used as an indicator of Group I intron presence. In *P. stypticus*, 75 of 76 Northern Hemisphere collections representing Eastern North America, Pacific North America, the Far East and Europe were ca. 1700 bp in length, suggesting intron presence (Jin, 2000). Only one collection in Eastern North America was heterozygous for the intron, showing two nLSU bands at ca. 1300 and 1700. In the Southern Hemisphere, six *P. stypticus* collections from New Zealand and three collections from Tasmania (Australia) lacked the nLSU intron, while the 3 collections from Australia (New South Wales) harbored the intron (Jin et al., 2001). In *D. pusillus*, the nLSU length of eight collections was ca. 1700 bp, but one collection 8733 from Mexico was heterozygous. The nLSU DNAs of six additional collections of *Dictyopanus* sp. were ca. 1700 bp long (Jin 2000). Three collections of *P. mitis*, three collections of *P. serotinus*, *P. ringens* exemplar 6711, *P. violaceofulvus* exemplar CBS391.50, and *P. longinquus* exemplar 6662 were all ca. 1300 bp, and lacked the intron.

Phylogenetic reconstruction of the *Panellus* complex based on nLSU sequences:

Parsimony analysis produced two most parsimonious trees treating gaps as a fifth character. The two trees differed in the relative positions of *Mycena rutilanthiformis* and *M. clavicularis*. Topology of the remaining taxa remained unchanged. Topology of the taxa was unchanged when gaps were treated as missing data. A bootstrap 50% majority rule consensus tree is shown in Fig. 2. The three *Mycena* species together with *Resinomycena acadiensis*, clustered with the *P. stypticus* / *D. pusillus* clade. *Panellus ringens*, *P. violaceofulvus* and *Pleurotopsis longinquus* formed a well-supported clade. *P. patellaris* and *P. serotinus* appeared on long branches but their relative positions were poorly supported. Unexpectedly, a sequence deposited as

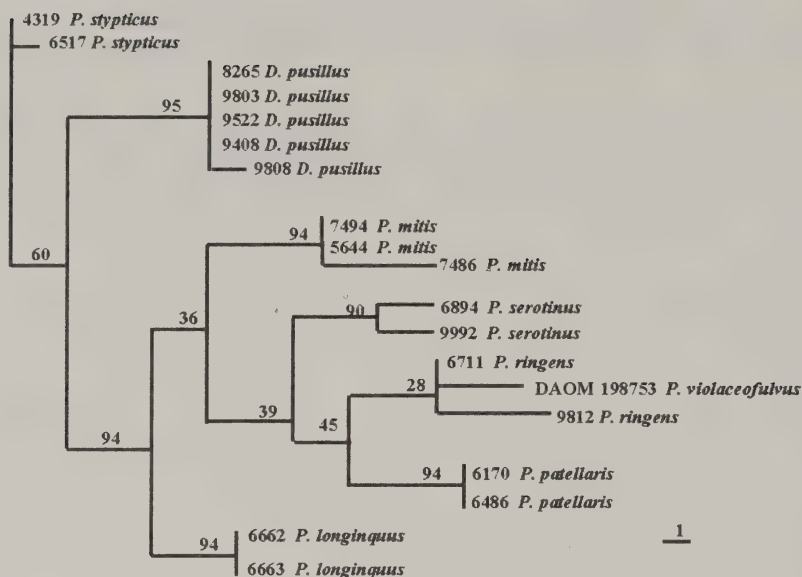


Fig. 1. A 50% majority-rule consensus tree based on morphological characters. Numbers indicate bootstrap support for the clade to the right of the node. All characters (20) were parsimony-informative. Tree length = 51. Consistency index = 0.67. Homoplasy index = 0.33

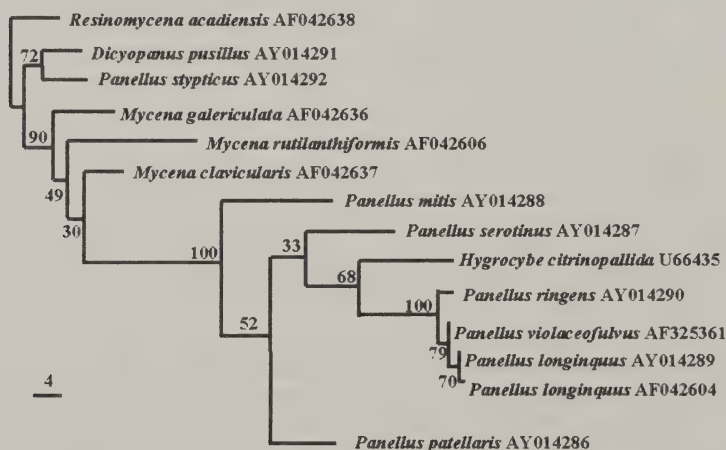


Fig. 2. A 50% majority-rule consensus tree based on 5'-partial LSU of ribosomal DNA sequences. Numbers indicate bootstrap support for the clade to the right of the node. Eighty-seven characters were parsimony informative. Tree length = 254. Consistency index = 0.72. Homoplasy index = 0.28. Collections AF042638, af042636, AF042606, AF042637, U66435 and AF042604 are from Moncalvo et al. (2000). For other collections, see Table 1.

Hygrocybe citrinopallida was nested between a clade consisting of *P. patellaris* and *P. serotinus* and a clade consisting of *Panellus ringens*, *P. violaceofulvus* and *P. longinquus*.

It is obvious that the current genus *Panellus*, with or without *P. patellaris* and *P. longinquus* included, is polyphyletic. *Panellus violaceofulvus* CBS391.50 is remarkably similar to *P. longinquus* (1 bp difference). *Panellus violaceofulvus* CBS391.50 was received as a culture from CBS collection, however, and is not anchored by a herbarium specimen. We thus cannot vouch for a correct identification.

DISCUSSION

Circumscription of the genus *Panellus* – recommendations: *Panellus* has been circumscribed in a number of different ways by previous researchers. The genus was established with only two characters, lateral stipe attachment and elliptical spores (Karsten 1879). However, the spores of *P. stypticus* are primarily phaseoliform to allantoid based on observation of world-wide collections in this study (Jin 2000).

Burdsall and Miller (1975), in agreement with findings above, described spores of *Panellus* (including *Dictyopanus*, *P. mitis*, *P. patellaris*, *P. serotinus*, *P. ringens*, and *P. violaceofulvus*) as “allantoid, oblong, ovoid to narrowly ovoid, smooth, hyaline, amyloid in Melzer’s reagent.” Basidiomata of *P. ringens*, *P. patellaris* and *P. violaceofulvus* are sessile, pendent, eccentrically attached to substrate, and are nonpanelloid. Clearly, those three species do not possess the character of lateral stipe attachment, which was established for the genus by Karsten (1879). Further, in *P. patellaris*, a membranous veil exists in young basidiomata, unique in this group, and was the basis for describing *Tectella* as a segregate monotypic genus (Earle 1909). Miller (1984) noted that *Panellus* was easily separated from other pleurotoid genera such as *Pleurotus*, *Panus*, *Cheimonophyllum*, *Pleurocybella*, *Hohenbuehelia* and *Resupinatus* in that the spores of the genus were amyloid in addition to elliptical and smooth.

The unexpected grouping of *P. ringens*, *P. violaceofulvus* and *P. longinquus* in the molecular analysis raised some interesting questions, since the culture used for LSU sequencing representing *P. violaceofulvus* was not anchored with a herbarium specimen. If the culture truly is *P. violaceofulvus*, then there is a remarkable morphological divergence between *P. longinquus* and *P. violaceofulvus* but little change in the LSU sequence. Alternately, the culture could represent *P. longinquus* but *P. longinquus* basidiomata have a gelatinous pileocutis, decurrent lamellae, and turn greenish black when rehydrated. This is quite different from sessile, pendent basidiomata of *P. violaceofulvus*. Further, *P. longinquus* is known from Australia, New Zealand and New Guinea (Horak, 1983), Pacific North America (Libonati-Barnes and Redhead 1984), and also from the Pacific coast of South America (Petersen and McClenaghan 1995, 1997). It is not known from Europe and this CBS collection from France would be an unexpected range extension.

Vilgalys and Hibbett (1991) stated that a genus should be based on monophyly and emphasized evolutionary history. In the *Panellus* complex, only the *P. stypticus*

and *D. pusillus* clade and the *P. ringens*, *P. violaceofulvus* and *P. longinquus* clade formed well-supported monophyletic groups. *Panellus mitis*, *P. patellaris*, *P. serotinus* formed monotypic clades.

Based on the above results, *Panellus* should include *P. stypticus* and *D. pusillus* only, with the other *Panellus* species assigned to separate genera. Under this concept, the genus *Panellus* could be defined morphologically as having panelloid stature, a lateral stipitate pileus and smooth amyloid spores. Probably, additional intersterility groups exist within poroid *Dictyopanus* (Corner 1986) and, pending further studies, these may also belong to this clade.

The presence of a Group I intron in both *Dictyopanus* and *Panellus stypticus* with a high level of homology supports the close relationship between these two groups (Burdsall and Miller 1975, 1978) and suggests that the intron was present in ancestral taxa prior to the separation of *Dictyopanus* and *Panellus*. These two genera clearly are in the same clade, supported by shared morphological characters, sequence similarity and presence of a nLSU Group I intron. *Panellus*, based on *P. stypticus* as type species, must be used for the *Panellus stypticus* / *Dictyopanus pusillus* clade, which may include additional poroid species.

Most of the remaining species in the *Panellus* complex have received separate generic placement: 1) *Pleurotopsis* (P. Henn.) Earle (1909) was an elevation of *Marasmius* subg. *Pleurotopsis* P. Henn. [type species: *Pl. spodoleucus* (Berk.) Earle]. Horak (1983) transferred *Panellus longinquus* into *Pleurotopsis*; 2) Karsten (1891) proposed the genus *Sarcomyxa* [type species: *S. serotina* (Fr.) Karst.; = *Agaricus serotinus* Fr.]; and 3) Earle (1909) proposed the monotypic genus *Tectella* [type species: *T. operculatus* (B. & C.) Earle; = *Panus operculatus* B. & C.; = *T. patellaris* (Fr.) Murrill, *teste* Singer (1975)]. *Tectella* was separated on presence of non-amyloid spores, pseudostipitate stature, and presence of a veil in early stage of basidiome development. [Note, however that Miller finds *T. patellaris* spores to be weakly amyloid O. Miller, pers. comm.]

Our results support these segregate genera. *Pleurotopsis* for *Pleurotopsis longinqua* – *Panellus ringens* clade; *Tectella* for *Tectella patellaris*; *Sarcomyxa* for *P. serotinus*. The transfer of *Pleurotopsis longinqua* from *Panellus* is warranted, based on the genetic distance between the *P. stypticus* / *D. pusillus* clade but would require an additional transfer of *P. ringens* to maintain the coherence of this clade. The position of *P. violaceofulvus* is suspect and requires more evidence from additional morphological examination and DNA sequences. *Tectella patellaris* has already been assigned a separate generic designation (Earle 1909). *Panellus serotinus* are well-separated from either of the terminal clades and probably requires separate generic assignment. Karsten's (1891) genus *Sarcomyxa* is typified by *P. serotinus* would be the correct name. We suggest that if a generic rank for *P. mitis* is advisable, *Mitellus*, elevated from subgenus status (Burdsall and Miller 1975, 1978), would be an appropriate name. Pending additional research, this name is not formally proposed here.

Lamellate and poroid hymenium – implications: Basidiomycetes or basidiomycota are basically divided as Agaricales versus Aphyllophorales (*sensu* Fries), or Agaricaceae / Boletaceae versus Polyporaceae *sensu* Smith (1949). Lamellate versus poroid hymenophores are typical characters that would dictate placement in an order or family.

Pegler (1983) suggested that the pleurotoid genera *Lentinus*, *Pleurotus* and *Panus* were derived from polyporoid ancestry (i.e., that pleurotoid fungi and Agaricales were convergent in the evolution of lamellate hymenophore structure). Conversely, Corner (1981) considered that monomitic hyphal structure was primitive and thus proposed an alternate phylogeny in which *Panus*, *Pleurotus* and *Lentinus* were a basal, paraphyletic group from which the Agaricales and Polyporaceae evolved. Hibbett and co-workers (Hibbett et al. 1997; Hibbett and Thorn 2001; Hibbett and Vilgalys 1991) placed *Panellus* and *Pleurotus* in the euagarics, and *Panus* and *Lentinus* in the polyporoid clade. Thorn et al. (2000), based on molecular data, further concluded that *Pleurotus* and *Hohenbuehelia* formed a monophyletic clade within the agaricales.

In the *Panellus* complex, a phylogeny based on the 5'-partial LSU gene revealed that *P. stypticus* and *D. pusillus* were nested in *Mycena* and *Resinomycena* clades. *Hygrocybe* was nested between a clade consisting of *P. mitis*, *S. serotinus*, *Tectella patellaris* and *P. ringens* and a clade consisting of *P. violaceofulvus* and *Pleurotopsis longinqua*. Thus, lamellate and poroid species, pleurotoid and nonpleurotoid genera are nested together. These results indicate that divergence of poroid and lamellate hymenophores has occurred repeatedly and often. Since poroid *D. pusillus* was nested within lamellate *Mycena* and *Resinomycena* clades, the poroid hymenium of *Dictyopanus* may be a derived character.

Inclusion of "panelloid" basidiome stature in a clade with distinctly centrally stipitate agaricoid stature (*Mycena*, *Resinomycena*) also suggests that basidiome stature is not plesiomorphic, but repeatedly derived. Considering the large number of taxa generally accepted in *Mycena*, it could be concluded that the "panelloid" stature is a derived state, perhaps linked to horizontal position on rotting wood, in which a long stipe as support for a pileus could be counter-productive. The other major clade of putative *Panellus* species (*P. ringens*, etc.) includes uniformly laterally to pseudostipitate basidiomata, and cannot be subjected to equal conjecture.

Considering other disparate groups of lamellate basidiomata in which presence or absence of stipe, and orientation and stature of the stipe appear to be repeatedly derived characters (i.e. *Pleurotus albidus* - *P. djamor*, *Lentinellus omphalodes* - *L. ursinus*; *Paxillus* vs. *Tapinella*, *Phylloporus* vs. Boletaceae, etc.), the situation in the *Panellus* complex is not unique, but because our analysis includes phenetic and molecular phylogenetic reconstructions, we think the point is worth emphasizing.

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TYPIIFICATION OF HYPOGYMNIA HYPOTRYPA AND *H. SINICA*

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Abstract. *Hypogymnia hypotrypella* is reduced to synonymy with *H. hypotrypa*. *Hypogymnia flavida* is described as a new species of lichenized fungi from east Asia, the esorediate counterpart of *H. hypotrypa*. *Hypogymnia sinica* is resurrected from synonymy with *H. pseudohypotrypa*.

Keywords. Ascomycota, Asia, *Hypogymnia*, lichens.

Examining the type material for *Hypogymnia hypotrypa* (herbarium BM) and *H. sinica* (herbarium HMAS) revealed that both are sorediate, but neither had been recognized as such. This resulted in a need for nomenclatural changes. Because the *Hypogymnia hypotrypa* group is so conspicuous and frequently collected in eastern Asia, we chose to publish these results now, rather than postponing the changes until more detailed studies of Asian *Hypogymnia* taxa are published.

Asahina (1950) segregated *Parmelia hypotrypella* as almost identical to *Parmelia hypotrypa* Nyl. but sorediate. The type material of *P. hypotrypa* is, however, sorediate. Therefore *H. hypotrypella* (Asahina) Rass. must be reduced to synonymy. No names are available for *H. hypotrypa* (Nyl.) Rassad in the sense of Asahina, necessitating a new name. *Hypogymnia flavida* McCune & Obermayer is thus described as a new species of lichenized fungi from east Asia. It is characterized by the presence of usnic acid rather than atranorin, absence of isidia and soredia, dark lobe cavities, large perforations in the lower surface, absence of physodic acid, and presence of physodalic and protocetraric acids by TLC. It forms the fertile counterpart in a species pair with *H. hypotrypa*.

Similarly, subtle soredia were previously overlooked on the type material of *Hypogymnia sinica* J. C. Wei & J. M. Jiang. The result in this case, however, is resurrection of *H. sinica* from synonymy with the esorediate species *H. pseudohypotrypa* (Asahina) A. Singh. *Hypogymnia sinica* and *H. pseudohypotrypa* appear related to *H. hypotrypa* and *H. flavida*, because of predominantly dichotomous branching, large perforations in the lower surface, dark cavities, and broad blunt lobes, but contain atranorin and physodic acid instead of usnic and physodalic acids.

Hypogymnia hypotrypa (Nyl.) Rass., Novosti sistematiki nizshikh rasteniy 1967:297. (Notul. System. e Sect. Cryptog. Inst. Bot. nomine V. L. Komarovii Acad. Sci. URSS) 1967.

Parmelia hypotrypa Nyl., Synopsis Lich. I:403. 1860.

Parmelia hypotrypella Asahina, Acta Phytotax. Geobot. 14:34. 1950.

Hypogymnia hypotrypella (Asahina) Rass., Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk. S.S.S.R. 13:23. 1960.

The type material of *Hypogymnia hypotrypa* is sorediate. In BM are four specimens mounted on a sheet and every specimen has small soredia, including one that Awasthi annotated as lectotype in 1984 (see photo in Awasthi 1984). The label data match those on the specimen of *H. hypotrypa* in H-NYL.

The specimen in H-NYL (No. 34197) is labeled "*Parmelia hypotrypa* Nyl. Himalaya, Sikkim, reg. alpina J. D. Hooker, K -" as in the original description. No collection numbers are cited by Nylander. According to Orvo Vitikainen, the specimen "consists of three fragments (ends of lobes, ca. 2 cm long pieces); two of them are non-sorediate, smooth above and more or less brownish tanned, the third one looks paler and has a wrinkled and eroded-sorediate upper side up to the lobe tips." Because esorediate lobe tips are frequent, even in the sorediate species, we conclude that all of this material probably belongs to the sorediate species, in accordance with the lectotype and other specimens of Hooker's collection from Sikkim in BM.

Unfortunately this results in *H. hypotrypella* being a synonym of *H. hypotrypa*, because *H. hypotrypella* was differentiated primarily on the basis of the presence of soredia. It also means that the esorediate species needs a new name.

Awasthi (1984) correctly selected a lectotype from the general collection in BM (derived from Hooker's collection), rather than one of the fragments in H-NYL, because the original text of Nylander (Syn.Lich.403) says: "*P. hypotrypa* Nyl. in hb. Hooker." The material from Hooker's collection in BM and that in H-NYL represent the same taxon from the same region (Sikkim), and are perhaps duplicates from the same collection.

Awasthi's application of "*H. hypotrypa*" is ambiguous. Awasthi (1984, 1988) said *H. hypotrypa* lacks soredia and isidia, but his lectotypification of *H. hypotrypa* is on clearly sorediate material. Awasthi's (2000) most recent list for India includes only *H. hypotrypa*. Based on the available specimens, the sorediate species is much more common in India than the esorediate species. So historically Awasthi correctly applied *H. hypotrypa* to the sorediate material, even though his description stated that it is esorediate. Awasthi (1988) stated that *H. pseudohypotrypa* is fertile and contains usnic acid, so it is probable that he applied this name to *H. flavida*. *Hypogymnia pseudohypotrypa*, however, contains atranorin and not usnic acid (Nuno 1964; see below).

Other authors (e.g. Rassadina 1960, 1967, 1971; Wei 1991; Nuno 1964) followed Asahina (1950). They applied "*H. hypotrypa*" to the esorediate species and "*H. hypotrypella*" to the sorediate species.

Sorediate (e.g. Kurokawa Lich.Rar.Crit.Exs. 223) and non-sorediate thalli of yellow Asian *Hypogymnia* are mostly rather easy to separate. But sometimes the development of soredia in *H. hypotrypa* is somewhat inhibited. Typically short, irregular cracks develop in the upper cortex, then flakes of the cortex and algal layer begin to detach from the medulla. These flakes are often marginally sorediate. Fertile specimens of *H. hypotrypa* are very rare (e.g. Obermayer 6934).

The chemistry of both *H. hypotrypa* and its esorediate counterpart *H. flavida* (see below) is fairly uniform, containing usnic and physodalic acids as major substances, protocetraric acid as a minor substance, and 3-hydroxyphysodic acid as an infrequent accessory. Other minor unknowns are present.

Hypogymnia hypotrypa has a broader geographic range than *H. flavida*. While *H. flavida* is known from the Himalayas, SW China, and Taiwan (locations below), *H. hypotrypa* is also known from Japan and Far East Russia.

***HYPOGYMNIA FLAVIDA* McCune & Obermayer, sp. nov.**

Fig. 1A

Thallus laxe adnatus vel imbricatus, ad 20 cm latus; lobis linearibus, libris, flavidi vel subviridibus, (1)3-6(10) mm latis; subtus niger, foraminibus magnis; sorediis isidiisque destitutis; apothecia brunnea; sporae 4.5-6 x 4-4.5 μ m. Cortex K-, KC+ flavescens; medulla K-, C-, KC-, P+ rubra.

Thallus loosely appressed to imbricate, to 20 cm or more broad or long, often confluent into mats; texture cartilaginous; branching mostly isotomic dichotomous, budding absent or rare; upper surface pale yellowish green, sometimes brownish toward the lobe tips, often with transverse black stripes or mottles, smooth, epruinose; lobes separate, black border sometimes visible from above; lobe profile even to $\pm$ nodulose; lobe width (1)3-6(10) mm; lobe width/height ratio 1-5; lobe tips often perforate, lower surface with conspicuous, large perforations; medulla hollow, ceiling and floor of cavity dark brown to black except near the lobe tips; soredia none, isidia none, lobules none.

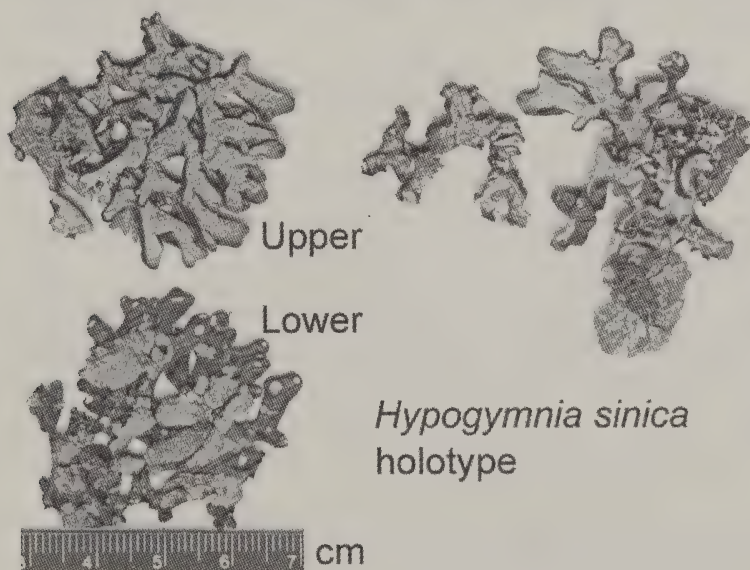


FIGURE 1. A. Habit of type specimen of *Hypogymnia flavida*. B. Habit of type specimen of *Hypogymnia sinica*.

Apothecia common, substipitate to stipitate, to 17 mm diameter or more; receptacle urn-shaped; stipe hollow, without septum; disk brown to reddish brown, spores subspherical, about $5.5 \times 5.0 \mu\text{m}$; hymenium about 27–30 μm thick; epihymenium clear brown; subhymenium 5–12 μm thick, of horizontally aligned hyphae, subtended by a hyaline, more parenchyma-like tissue (hypothecium) 25–30 μm thick, with scattered yellowish birefringent granules; pycnidia (spermagonia) frequent, spermatia rod shaped to weakly bifusiform, $5.0\text{--}5.5 \times 0.5\text{--}0.8 \mu\text{m}$.

Chemistry—Spot tests: cortex P-, K-, C-, KC+ yellow; medulla P+ orange-red, K-, C-, KC-. Lichen substances by TLC: usnic and physodalic acid constant (major), protocetraric acid constant (minor), 3-hydroxyphysodalic acid infrequently present.

Type—CHINA: YUNNAN PROVINCE: Luquan County, Jiao Zi Mountains north of Kunming, forest of *Abies georgei* and *Rhododendron*, upper slopes of mountain, $26^{\circ} 06' \text{N}$ $102^{\circ} 52' \text{E}$, 3700 m, on *Abies*, September 2000, McCune 25622 (holotype, OSC; isotypes, CANB, GZU, M, NY, UPS distributed in "Dupla Graecensia Lichenum").

Paratypes—CHINA. SICHUAN PROVINCE. Muli County: in monte Gibboh, 3550 m, *Rock s.n.*, Crypt.exs. 3575 (LAM, US); Ludiang Co., Gongga Shan, Hai-luo-gou, $29^{\circ} 25' \text{N}$ $101^{\circ} 40' \text{E}$, 2800 m, *Wang L.-s. 16916* (HKAS); Xiangchen County, Da-xue Mt., $30^{\circ} 30' \text{N}$ $101^{\circ} 30' \text{E}$, 3900 m, *Wang L.-s. 2286* (HKAS). TIBET (XIZANG PROVINCE). Ri-dong, $28^{\circ} 35' \text{N}$ $98^{\circ} 10' \text{E}$, 3500 m, *Zang M. 10313* (HKAS); 40 km SW of Mainling, $29^{\circ} 03' \text{N}$ $93^{\circ} 56' \text{E}$, 4000 m, *Obermayer 6109* (GZU); Nyainqentanglha Shan, 360 km E of Lhasa, bend of Tsangpo River, $29^{\circ} 55' \text{N}$ $94^{\circ} 52.5' \text{E}$, 3350 m, *Obermayer 7344* (GZU). YUNNAN PROVINCE. Lijiang, in silvis montis Ndaza Ko, 4000 m, *Rock, s.n.*, Zahlbruckner, Lich.Rar.Exs. 278b and 312 (US); Yulong Shan Mts, 30 km E Lijiang, 4000 m, Sojak, s.n., Vězda, Lich.sel.Exs.2449 sub *H. hypotrypella* (BM, US); NEPAL. Mewa Khola, path near Topke Thola, 3350 m, *Norkett 9318* (BM). TAIWAN: Chiayi Co, Mt. Alishan, *Wang-Yang s.n.* (US); Hualien Co. Mt. Hohuanshan, 3200 m, on *Abies*, Yoshida 7000, Kashiwadani, Lich.Minus Cogn. Exs. 68 (BM, US); Nantou Co., Mt. Morrison, Payun Hostel to the peak, $23^{\circ} 56' \text{N}$ $120^{\circ} 40' \text{E}$, 3700 m, *Lai 10426* (US).

Ecology and substrate—*Hypogymnia flavida* occurs on bark and wood, usually on conifers, but frequently also on *Rhododendron*, less often on *Quercus* and other hardwoods, occasional on mossy rocks. The species is found in mesic coniferous and *Rhododendron* forests, mainly in the mountains of southwestern China.

Variation—Both *H. flavida* and *H. hypotrypa* are highly variable in thallus size and lobe width and length. *Hypogymnia flavida* particularly has a broad morphological range. Some specimens have very long, rather narrow, and sparsely branched lobes. This form also develops black transverse stripes formed by the confluent pigmented areas associated with pycnidia (spermagonia). Nylander named this "forma *balteata*" in reference to the black belts or stripes (e.g. Obermayer 6025; Vezda, Lich.Sel.Exs. 115; Cryptog.Exs.Vindobon. 3575).

At the other extreme are specimens of *H. flavida* with rather broad, richly branched thalli, often apotheciate (e.g. Vezda, Lich.Sel.Exs. 2449; Kashiwadani, Lich.Min.Cogn. 68). Although one might regard these extremes as different taxa, intermediates are fairly common (e.g. Obermayer 6118; 6024). Perhaps production of apothecia is developmentally linked to broader lobes, but some specimens of "*f. balteata*" are fertile.

Hypogymnia sinica J. C. Wei & J. M. Jiang, Acta Phytotax. Sin. 18:386. 1980. Type in HMAS!

See discussion under *H. pseudohypotrypa*.

Hypogymnia pseudohypotrypa (Asahina) A. Singh Lichenol. Ind. Subcontinent 1966-1977.

Eco. Bot. Inform. Serv. Nat. Bot. Res. Inst. Lucknow 2. 1980. (Superfluous combination later made by Wei, Enum. Lich. China p. 117. 1991.)

Parmelia pseudohypotrypa Asahina apud Nuno, J. Jap. Bot. 39:99. 1964. Type presumably in TNAS (not seen).

The type material of *H. sinica* has some small, poorly developed yet distinct soredia, similar in form to those in *H. hypotrypa*. This was mentioned in protologue: "...interdum pro

parte corticibus fragilibus vel subsorediosis ...” Specimens of *H. sinica* collected in Yunnan by Wang Li-song and the senior author have more clearly developed soredia. The presence of soredia leads us to reject Wei's (1991) conclusion that *H. sinica* is a synonym of *H. pseudohypotrpya*. The latter has abundant large apothecia, as shown in Nuno's (1964) photo of the type specimen. *Hypogymnia sinica* appears to be a good species, presently known from SW China. The type of *H. sinica* has atranorin and physodic acid.

Unfortunately we have not seen the type for *H. pseudohypotrpya*. Nuno (1964) in the original description of *P. pseudohypotrpya* said it contains atranorin and physodic acid, rather than usnic and physodalic acids. Inexplicably, Awasthi (1988, p. 236) stated usnic and physodic acid as lichen substances for *H. pseudohypotrpya*, although Awasthi (1984) reported atranorin and physodic acid.

Because of the confusion regarding *H. pseudohypotrpya* and *H. sinica*, the distribution of these species remain uncertain. Further work delimiting *H. pseudohypotrpya* from other esorediate species in southern Asia is needed.

Hypogymnia sinica, on the other hand, is easily distinguished from other *Hypogymnia* species except for *H. pseudophysodes*. The form of the soralia is similar in *H. sinica* and *H. pseudophysodes*, but the latter has narrower lobes (typically 1-2 mm vs. 2-5 mm for *H. sinica*) with tapered lobe tips, and is distributed mainly in northeastern Asia.

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CALOPLACA NASHII SP. NOV. (TELOSCHISTACEAE, LICHENES), A NORTH- AMERICAN SPECIES OF THE C. LACTEA-GROUP GROWING IN CALICHE

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Abstract : Description is provided of *Caloplaca nashii* sp. nov., a saxicolous-calcicolous lichen growing on caliche in arid regions of Baja California (Mexico). It is related to the *C. lactea* group by its poorly developed thallus, lacking anthraquinones, and spores with short wall thickening (isthmus) less than 3 μm . However, it differs from the known species of this group by having shorter and narrower ellipsoid spores, (10)11.5-16(19.5) $\times$ (4)4.5-6 μm . *Caloplaca lactea* var. *americana* is considered as a probable synonym of *C. holocarpa*.

Key words: *Caloplaca*, taxonomy, new species, Baja California, Mexico.

Resumen: Descripción de *Caloplaca nashii* sp. nov., un líquen saxícolo-calcícola que crece sobre caliche en las zonas áridas de Baja California (México). *C. nashii*, por tener el talo escasamente desarrollado, sin antraquinonas, y esporas provistas de un engrosamiento ecuatorial de la pared corto, de menos de 3 μm , esta relacionada con las especies del grupo de *C. lactea*, pero se diferencia de las especies conocidas de este grupo por tener esporas cortas y más eschechamente elipsoidales, de (10)11,5-16(19,5) $\times$ (4)4,5-6 μm . *Caloplaca lactea* var. *americana* es considerada un posible sinónimo de *C. holocarpa*.

Palabras clave: *Caloplaca*, taxonomía, especie nueva, Baja California, México.

Resumo : Priskribo de *Caloplaca nashii* sp. nov., petroloĝa likeno, kiu keskas sur malgrandaj kalkŝtonoj ("caliche") de la dezertaj regionoj de Malalta Kalifornio (Meksikio). *C. nashii* parencas al la specioj de la grupo de *C. lactea* pro talo malbone videbla, senantrakinona, kaj sporoj kun ekvatora dikaĵo mallonga (nur ĝis 3 μm), sed bone diferencas de la konataj specioj de tiu grupo pro mallongaj sporoj, pli maldike elipsoidaj, nur (10)11,5-16(19,5) $\times$ (4)4,5-6 μm . Rimarko pri *Caloplaca lactea* var. *americana*, ebla sinonimo de *C. holocarpa*.

Ŝlosilvortoj: *Caloplaca*, taksonomio, nova specio, Malalta Kalifornio, Meksiko.

Introduction

During the field trip to the Sonora and Baja California deserts (Mexico), organized by Professor T. H. Nash III in February 1993, the first author collected from different localities lichens growing on slabs or small carbonated pebbles, which were result of the alteration of calcium carbonate zones (caliche). Caliche is a term applied in SW U.S.A. to a calcareous material of a secondary accumulation, commonly found in layers on or near the surface of stony soils of arid and semi-arid regions. It is composed largely of crusts of soluble calcium salts in addition to such material as gravel, sand, silt and clay. The cementing material is essentially calcium carbonate (BATES & JACKSON 1987).

Among those lichens there was a *Caloplaca* characterized by an inapparent or poorly developed thallus and spores with a very reduced equatorial wall thickening, less than 3 μm wide, that was related to the taxa of the *C. lactea* group. However, it did not match to any of the treated species in the review of this group (NAVARRO-ROSINÉS & HLADUN 1996). After consulting the main bibliography referred to this genera in North America (ARUP 1992 a-b, 1993 a-b, 1994, 1995 a-b, 1997, 1998; KÄRNEFELT 1998; NIMIS *et al.* 1994; WEBER 1989; WETMORE 1994, 1996, 1999; WETMORE & KÄRNEFELT 1998, 1999), and the most important keys based on *Caloplaca* (CLAUZADE & ROUX 1985, EGEA 1984, HANSEN *et al.* 1987, LAUNDON in PURVIS *et al.* 1992, NIMIS 1992, POELT 1969, POELT & HINTEREGGER 1993, RYAN 1998, WADE 1965), we considered that the studied *Caloplaca* belongs to a hitherto unpublished species.

The new taxon is named in honour of Professor Thomas H. Nash III (Arizona State University, Phoenix), lichenologist who, in order to promote the study of lichens from the arid regions of western North America, organized several field trips.

Material and methods

In order to study the different specimens of *Caloplaca*, hand-made sections of the thallus and apothecia were examined with the light microscope (up to $\times 1000$). These sections were mounted in water or, to increase the contrast, in lactophenol–cotton blue. All measurements were made in water. In the spore size, the range (given in non-italics and outside parenthesis) was calculated after rejecting 10% of the highest and the lowest values. The averages are in italics, and the extremes are given in parenthesis. A drawing tube fitted to the microscope was used to make the drawings.

Caloplaca nashii Nav.-Ros., Gaya et Hladun sp. nov.

Thallus crustaceus, endolithicus aut parum epilithicus, parum vel non distinctus, albidus vel albidus flavescens, K - . Alga protococcoidea, cum cellulis 12–22 μ m. Apothecia 0.2–0.4(0.5) mm, aurantia, K+ (purpureum), primum in thallo immersa, deinde sessilia ; discus primum concavus, deinde planus ; margo concolor disco, primum crassa et eminens, deinde tenuis et parum eminens. Epithecium bruneum aurantiacum, K+ (purpureum). Hymenium 70–80 μ m altum. Hypothecium sine colore. Parathecium cum cortice epithecio simili et medula sine colore, prosoplectenchymaticum, clare distincte radiantibus hyphis constitutum. Amphithecium in inferiore apothecii parte minutum. Paraphyses clare septatae, non aut tantum in summa parte ramosae, cum base 1.5–2 μ m et summa parte 2.5–4 μ m μ m crassa. Asci (50)57–63 $\times$ 10–13 μ m, typo familiae Teloschistaceae, octospori, raro tetraspori. Ascosporae polariloculares, hyalinae, longe ellipsoideae, (10)11.5–16(19.5) $\times$ (4)4.5–6 μ m, cum media densatione (1)1.5–2.5(3) μ m longa.

Typus: México, Baja California Norte, 6 km north of El Rosario, along route 1 to San Quintín, 30 7° 0' N, 115 46° 0' W, 300 m alt., carbonated slabs and small stones of the ground (caliche), 23.II.1993, *P. Navarro-Rosinés* (BCC-lich. 13459- Holotypus, 13460 to 13466- Isotypi; ASU, GZU, MIN, MARSSJ, -Isotypi).

Description

Thallus endolithic, not or scarcely distinct, or crustose and in part epilithic, granular or forming a thin, continuous thallus, rarely cracked or weakly cracked areolate; mainly white but, in some specimens, it can be slightly yellowish, K-. Photobiont protococcoid, with individual

globose cells 12-22 μm diam.

Ascomata apothecia, 0.2-0.4(0.5) mm diam., abundant, scattered or confluent in groups, crowded or even contiguous, orangish, K+ (purple), rounded, but deformed by mutual compression when grouping, sessile at maturity, immersed in the thallus only at the beginning. Disc orange, finely rugose, concave when young but becoming flat when mature, with scarce concolorous pruina. Margin of the same colour as disc, smooth, entire, at first somewhat thick and prominent, becoming thinner and not prominent at maturity (at the same level as disc).

Epithenium brownish yellow, K+ (purple), with irregular surface, 7-10 μm thick.

Hymenium 70-80 μm thick, hyaline.

Subhymenium and **hypothecium** distinct from each other and hyaline. The former thick, rich in oil droplets (inspersed), the latter thin, extending by the parathecium, with a structure intermediate between para- and prosoplectenchymatous and rounded or somewhat elongated cells, $2.5-5.5 \times 1-2(2.5)$ μm diam.

Parathecium relatively thin, (40)60-100 μm thick, prosoplectenchymatous, composed of radiating hyphae with elongated cells, (5)7-13(16) $\times$ (0.5)1-2 μm , with very narrow cell lumina. Only in the outer zone, in contact with the pigmented area, showing more distended cells, 2-4 μm thick.

Amphithecium hardly distinct, persisting on the basal part of apothecia margin, where some packed algal cells are distinguished.

Paraphyses septate, not or scarcely branched, 1.5-2 μm wide at the base and 2.5-4 μm wide at the apices, with 1-2 apical cells covered with anthraquinone crystals, K+ (purple).

Asci (50)57-63 $\times$ 10-13 μm , clavate, of *Theloschistes*-type, 8-spored, occasionally 4-spored.

Ascospores colourless, polarilocular, narrowly ellipsoid or faintly cylindrical-fusiform, (10)11.5-13.7-16(19.5) $\times$ (4)4.5-5.0-6 μm , with an equatorial wall thickening (isthmus), (1)1.5-2.1-2.5(3) μm wide, with a length/width quotient: (1.7)2.2-2.8-3.5(3.9), and length/equatorial wall thickening quotient: (4)5-7.1-10(17), ($n = 50$).

Discussion and affinities

Caloplaca nashii belongs to the *C. lactea* group (Massal.) Zahlbr. (Navarro-Rosinés & Hladun 1996), with which it shares habitat and the spore's shape. *Caloplaca lactea* group includes taxa occurring on calcareous rocks and it is characterized by spores with a short



Fig. 1. *Caloplaca nashii*. A.- cross-section of an apothecium, (semi-schematic). B.- cross-section of a parathecium (LPCB).

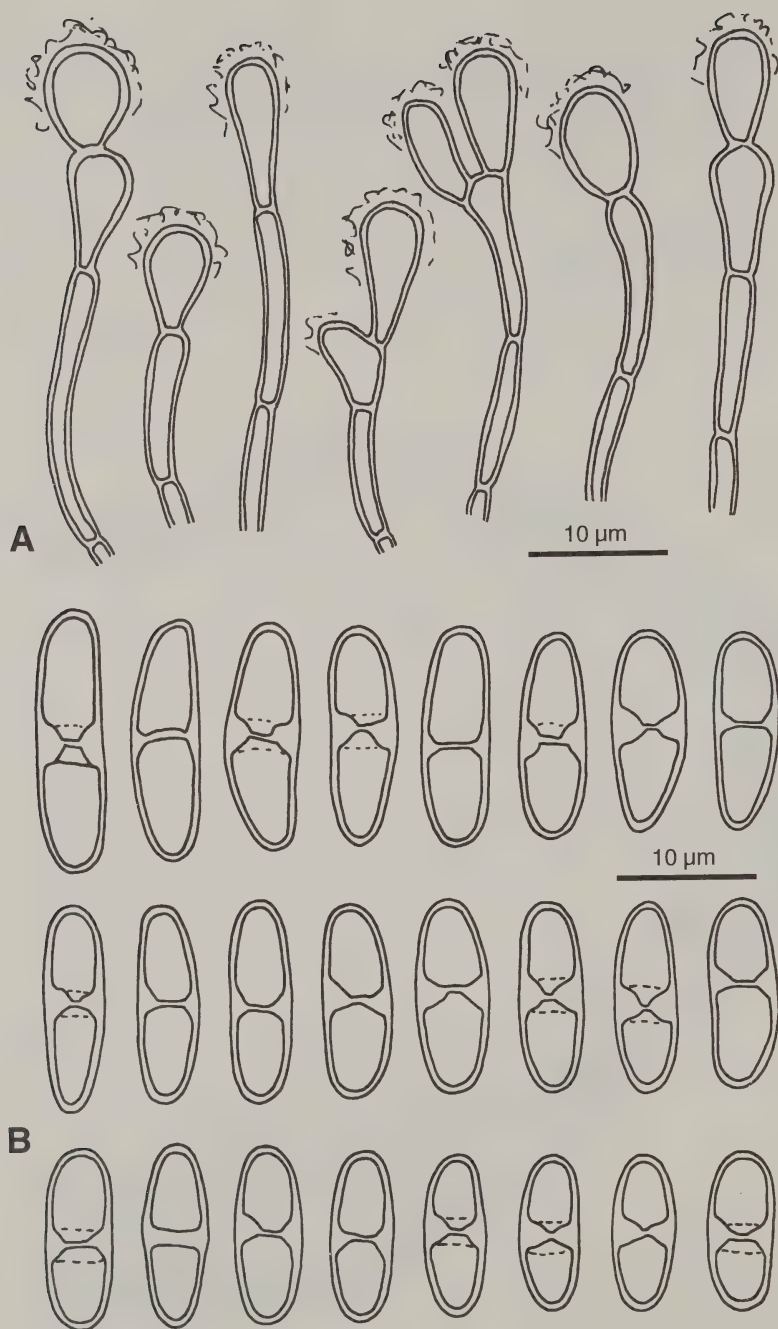


Fig. 2. *Caloplaca nashii*. A.- Paraphyses. B.- Ascospores (LPCB).

equatorial wall thickening of less than 3 μm length. Amongst other characters, *C. nashii* differs from the known species of the *C. lactea* group (see Tab. 1) by having narrower spores.

C. nashii occurs on small calcareous stones situated on the ground. This habitat is shared by some species of the *C. lactea* group, with which *C. nashii* should be compared in more detail. These species are: *C. lactea* (Massal.) Zahlbr., *C. lacteoides* Nav.-Ros. et Hladun and *C. marmorata* (Bagl.) Jatta (NAVARRO-ROSINÉS & HLADUN 1996).

C. lacteoides is characterized by its yellowish-toned apothecia, by being the species of the group with the longest spores, which have a long ellipsoid or subfusiform shape, and by having paraphyses tips strongly capitated at the end of their development, with apical cells 5-9 μm wide. *C. marmorata* is easy to recognize by its reddish coloured apothecia and by having abundant apically or subapically branched paraphyses.

C. nashii is more closely related to *C. lactea* than the other species mentioned due to its typical orange colour. However, both taxa are readily distinguished by the shape as well as by the dimensions of the spores. *C. lactea* has wider ellipsoid spores than *C. nashii*, with its $11-14(16) \times 6-8.5(9.5) \mu\text{m}$.

The well-developed thalli of *C. nashii* may also look similar in habit to those of *C. navasiana*, a *Caloplaca* from the *C. velana*-group which grows on blocks or wide ledges of calcareous rock in the Mediterranean littoral zone (NAVARRO-ROSINÉS & ROUX 1994). In both taxa the thallus is practically always lacking anthraquinones, with white-ochre or very occasionally slightly yellowish tonality in some part of the thallus. They are also characterized by orangish apothecia and a faintly pruinose disc. These taxa clearly differ in their habitat and in the characteristics of the spores, which in the case of *C. navasiana* shows an equatorial wall-thickening that has a length of about 1/3 or more of the spore.

Distribution and habitat

C. nashii is only known in the desert zones of the Baja California region (Mexico), where it occurs on calcareous stones and rock slabs situated on the ground. These stones are detached from the underlying superficial deposit of carbonates (caliche).

The number of lichen species occurring upon these substrata is very scarce, among them, the most abundant taxa is always *C. nashii*. It is the only lichen able to developing on the smallest pebbles with a diameter less than 3 cm. Other small thalli from other lichens grow when the stones are bigger. Among these we identified: *Buellia sequax*

(Nyl.) Zahlbr., *Lecanora crenulata* (Dicks.) Hook., *Lecania turicensis* (Hepp) Müll. Arg., *Rinodina bischoffii* (Hepp) Massal., *Verrucaria calciseda* DC. and *Verrucaria macrostoma* Duf. ex DC. f. *furfuracea* B. de Lesd. The latter is rarely fruited, but it is easily recognizable by the small isidia occurring on the margin of the areoles.

A part from the lichens mentioned above, on these stones it has been observed that the greater part of the substratum can be colonized by an endolithic lichen which does not fruit. On its thallus occurs *Polycoccum opulentum* (Th. Fr. et Almq.) Arnold, a lichenicolous fungus which grows on endolithic thalli of diverse calcicolous *Verrucaria* (NAVARRO-ROSINÉS & ROUX 1990). The presence of this fungus makes us suppose that it may correspond to *Verrucaria calciseda*.

Further, two lichenicolous fungi are located growing on *Caloplaca nashii*: an *Opegrapha* of the *rupestris*-group, characterized by small ascomata, and a new species of *Lichenochora*, described as *L. epinashi* Nav.-Ros. et Etayo in other paper (NAVARRO-ROSINÉS & ETAYO, in press)

Additional specimens examined

- México: Baja California (N), 6 km N of El Rosarito along Hwy 1, on top of mesa, 30° 7' N, 115° 46' W, 280 m alt., caliche, 23.II.1993, *C. M. Wetmore* 72361, 72363 and 72387 (MIN).

- México: Baja California (N), 13 km S of Rosarito in arroyo leading to ocean, 28° 33' 12" N, 114° 3' 36" W, 25 m alt., caliche, 1.IX.1998, *C. M. Wetmore* 79795, 72363 and 72387 (MIN).

- México: Baja California Sur, Santa Rosalia to Guerrero Negro, Desierto de Vizcaíno, Llano El Angel, N of San Ignacio, 3.5 km from highway 1 along road to Punta Abreojos, 27° 15' N, 113° 11' W, 60-260 m alt., caliche, 21.II.1993, *P. Navarro-Rosinés* (BCC-lich. 13533-13540).

- México: Baja California Sur, La Paz to Constitución, 76 km WNW of La Paz along route 1, 24° 21' N, 111° 10' W, 110 m alt., caliche, 17.II.1993, *P. Navarro-Rosinés* (BCC-lich. 13541).

Other taxa studied for comparison features

Caloplaca lactea var. *americana* B. de Lesdain

Annal. Cryptog. Exot. 5(2) :124 (1932)

Typus : USA, New Mexico, Las Vegas, Thunderbird Ranch, 1890 m alt., silic. rock, 04.II.1929, *G. Arsène Brouard* (US-68075) [lectotype selected here].

The study of the typus of *Caloplaca lactea* var. *americana* B. de

	<i>C. nashii</i>	<i>C. lactea</i>	<i>C. marmorata</i>	<i>C. lacteoides</i>
Thallus	endolithic or not rarely granular or fissurate on surface	endolithic or with some superficial granulation	endolithic, or with rarely some superficial granulation	endolithic or forming a thin whitish layer
Apothecium Diameter Disc colour	0.2-0.4(0.5) mm orange	0.1-0.3 mm orange	0.2-0.5 mm orangish brown, rust or vermillion red	0.2-0.5 mm vitelline yellow, yellow ochreous, to orangish brown
Parathecium Thickness Structure	(40)60-100 µm, prosoplectenchymatous,	70-110 µm, prosoplectenchymatous,	150-250 µm prosoplectenchymatous,	to 120 µm prosoplectenchymatous in the inner part, but with a paraplectenchymatous external layer,
Cells	elongated and narrow cells, (5)7-13(16) × (0.5)1-2 µm, with external cells more enlarged, with 2-4 µm Ø	cells with ± constant size in all the thickness, (5)6-9 × 1-1.5(2) µm, but with some external cells more enlarged, with 3-5 µm Ø	cells with constant size in the whole thickness, 6-9 × 3-5 µm	elongated and narrow cells in the inner part, (7)10-14 × 2 µm, rounded in the external layer, 6-10 µm Ø
Paraphyses Branching Apical swelling	unbranched apical cell not or hardly enlarged, 2.5-4 µm Ø	unbranched, more rarely forked apical cell only slightly enlarged, up to 5 µm Ø	apical- and subapical abundantly branched 1-4 enlarged apical cells, 5-7 µm Ø	unbranched, rarely forked not swollen when young, but strongly capitate when mature, 5-9 µm Ø
Asci	(50)57-63 × 10-13 µm, (4)8-spored	55-65 × 13-17 µm, 8-spored	60-70 × 16-20 µm, (2-4)8-spored	60-70 × 16-20 µm, 8-spored
Ascospores Shape Size Equatorial wall thickening	narrowly ellipsoid or (sub)cylindrical (10)11,5-16(19) × (4) 4,5-6 µm (1)1,5-2,5(3) µm	widely ellipsoid 11-14(16) × 6-8,5(9,5) µm (1)2-3(3,5) µm	ellipsoid (12)13,5-19(21) × 5-7(8) µm (1)2-3 µm	longly ellipsoid or (sub)fusiform 16-21(25) × (5)5,5-7 µm 1-2(2,5) µm

Table 1. The main distinguishing characters for the related species of the *Caloplaca lactea* group growing on slabs or small carbonated pebbles.

Lesdain (1932), revealed that this infraspecific taxon is not related to the *Caloplaca lactea* group. The mature spores measure $12-13.0-14 \times 6-7.0-7.5(-8) \mu\text{m}$, and show an equatorial wall thickening of $3.5-4.5 \mu\text{m}$, which is approximately $1/3$ of the length of the spore. Thus, this equatorial wall thickening is longer than the maximum of $3 \mu\text{m}$ that reach most of the species of the *C. lactea* group.

If we try to determine this specimen with the main *Caloplaca* keys (see introduction), we find a number of characters that match with the concept of *Caloplaca holocarpa* (Hoffm.) Wade, in the sense adopted by CLAUZADE & ROUX (1985) and WIRTH (1995). The main concordances are in the size and features of the spores (as mentioned above), the thallus nearly absent and, in the apothecia, the presence of a distinct proper margin, concolorous with orange disc, and the thalline margin scarcely apparent, reduced and located to the base of apothecia, coloured in orangish grey or orangish green.

It should be pointed out that *C. holocarpa* is an unclear taxon which has been regarded differently, as different authors indicate, e.g. NIMIS (1993). Actually it seems that this taxon has become a jumble of

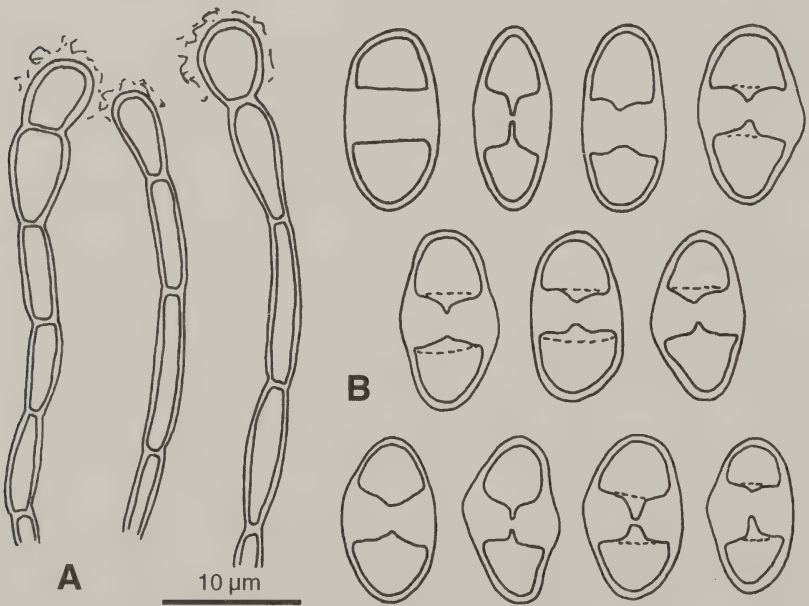


Fig. 3.- *Caloplaca lactea* var. *americana*. A.- Paraphyses. B.- Ascospores (LPCB).

different things in many floras. Therefore, it has been included in *C. holocarpa* both epiphytic and saxicolous specimens and, in the latter case, calcicolous as well as silicicolous (see for example: PURVIS 1992, CLAUZADE & ROUX 1985, WADE 1965 and WIRTH 1995).

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ASPIDOTHELIUM GEMMIFERUM SP. NOV., FROM PAPUA NEW GUINEA (LICHENIZED ASCOMYCETES)

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Abstract: The foliicolous lichen *Aspidothelium gemmiferum* is described from lowland rainforest along the northern coast of Papua New Guinea; it is easily distinguished by the production of disc-like isidia on the prothallus. A key to all known species of *Aspidothelium* is provided.

Key Words: Foliicolous lichens — Thelenellaceae — disc-like isidia — Australasia

Foliicolous lichens are very diverse in Papua New Guinea and include several fascinating genera and species, such as *Byssoloma gahavisukanum* with sporodochia, *Hippocrepeida nigra* with horseshoe-shaped hyphophores, *Musaespora coccinea* with bright orange perithecia and campylidia, *Phyllocratera papuana* with large flattened perithecia and muriform ascospores, and *Sporopodiopsis mortimeriana* with complex conidiomata (APTROOT et al. 1997, SÉRUSIAUX 1997). Amongst the large collections gathered by the first author in that country during two expeditions in 1992 and 1995, a new foliicolous species of *Aspidothelium* has been found and is described in this paper.

The genus *Aspidothelium* Vain. is characterized by the following features: ascomata perithecioid, usually with disc-like or verruciform protuberances, asci clavate, fissitunicate, with very thick walls and a small but distinct ocular chamber, paraphyses simple, occurrence of periphyseae, ascospores fusiform to ellipsoid, transversely septate or muriform, and a chlorococcoid photobiont.

Eleven species (incl. the one described in this paper) occur on living leaves but only two [*A. fugiens* (Müll. Arg.) R. Sant. and the recently segregated *A. scutelliarum* Lücking] are rather common and pantropical. Since the outstanding monograph of SANTESSON (1952), new foliicolous species of *Aspidothelium* have been described in SÉRUSIAUX (1978) and LÜCKING (1999a), or mentioned as 'ined.' in LÜCKING (1999b) and LÜCKING & KALB (2000).

In his most remarkable taxonomical survey of the pyrenolichens, HARRIS (1995: 160-167) suggested that *Aspidothelium* belongs to the Thelenellaceae and should be reduced into synonymy with *Thelenella* Nyl. LÜCKING (1998) discussed this concept and reached the conclusion that *Aspidothelium* and *Thelenella* feature a number of differences that support their separation at generic level: perithecia exposed vs immersed in thalline verrucae, structure of asci and paraphyses (see contradictory findings by ERIKSSON, 1981 and HARRIS, 1995) and different ascospore types, those of *Aspidothelium* being unmistakable. This view was confirmed by H. Mayrhofer (pers. comm. 1997).

Aspidothelium gemmiferum Sérus. & Lücking sp. nov.

Species foliicola ab omnibus aliis generis *Aspidothelii* valde distincta scutellis discoideis umbilicatisque, 0.15-0.2 mm diam., in prothallo copiose instructo. Perithecia c. 0.6 mm diam., basi distincte constricta, pallide aurantiaca. Ascosporae fusiformes, 13-15-septatae, 61-70 x 14-16 µm.

Type: Papua New Guinea, Madang prov., S side of Ramu river, Brahman Mission, c. 8-10 km W of Brahman Mission, 5°45'S 145°20'E, 100 m, logging site in forest remnant, 29 X 1995, E. Sérusiaux 15704 (LG, holotype).

Description: **Thallus** foliicolous, rounded or irregular, up to 1.5 cm in diam., made of scattered aligerous patches with a rather wrinkled surface, and a distinct, albeit pale grey and almost translucent, rather shiny prothallus. **Disc-like isidia** rather abundant (max. 40-45/cm²), present only on the prothallus, rarely contiguous, 0.15-0.2 mm in diam., translucent to pale greyish, at first adnate on the thallus surface and when mature typically discoid and umbilicate, with a slightly dissected margin, containing no algal cells or very few near its centre, made of long, transversely septate hyphae radiating from the central part of the disc and with a fringe of individual hyphae protruding out of the disc and usually with a hooked tip (easily seen under SEM). **Perithecia** few, at first seen as hemispherical, pale orange verrucae; when mature sessile, c. 0.6 mm in diam. and c. 0.45 mm high, distinctly constricted at the base, pale orange, with a few dark orange spots, especially near the ostiole, with the outer surface rather irregular; ostiole central, in a slight depression. Outer perithecial wall 150-200 µm thick, typically paraplectenchymatous, with rounded cells 6-12 µm in diam. and some up to 16 µm in diam., many dead and empty and thus forming a lacunose plectenchyma; inner perithecial wall thin, prosoplectenchymatous; paraphyses abundant, long and simple, c. 1.5 µm thick; periphyses abundant, simple, c. 1.5

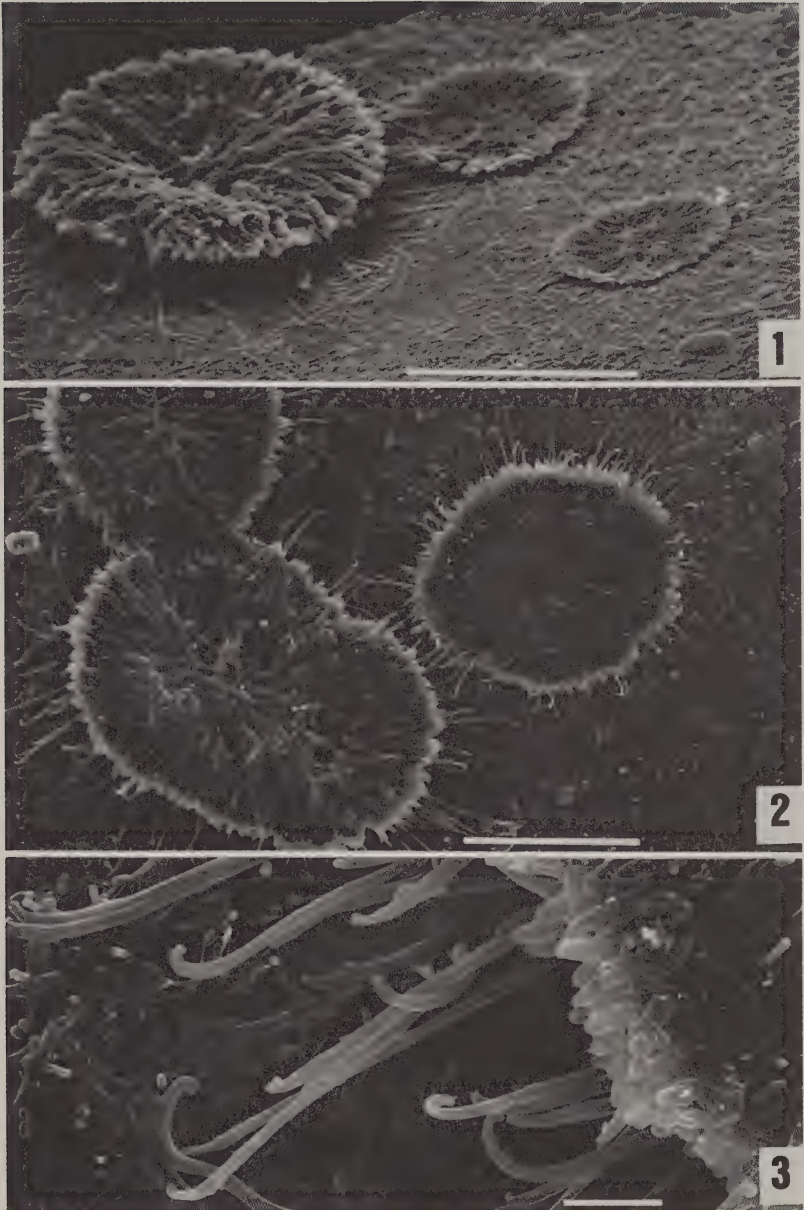


Fig. 1-3. *Aspidothelium gemmiferum* (holotype): SEM views of the disc-like isidia.
Scale bars: 100 μm for 1-2 and 10 μm for 3.

μm thick; asci clavate, with very thick walls and a small but distinct ocular chamber; ascospores 2-4 per ascus, fusiform, with rather acute ends, 13-15-septate, $61\text{-}70 \times 14\text{-}16 \mu\text{m}$. **Photobiont** a species of the Chlorococcaceae, most probably *Trebouxia*.

Notes: *Aspidothelium gemmiferum* can easily be distinguished by the typical and numerous disc-like isidia occurring on its prothallus. No other species in the genus has such an asexual mean of dispersal. The other species with transversely septate ascospores can be identified with the key provided below.

The perithecia of *Aspidothelium gemmiferum* somewhat resemble those of the type material of *Phylloporina macrospora* Müll. Arg. from Brazil, so far considered a synonym of *A. fugiens* (SANTESSON 1952) but most probably belonging to another species (LÜCKING 1999a). This material lacks any disc-like isidia and is otherwise well-developed: its genuine identity remains to be established.

Disc-like, and sometimes umbilicate, asexual diaspores can be found in several species of foliicolous lichens belonging to completely different groups: *Phylloblastia dolichospora* Vain. (incertae sedis), *Chroodiscus mirificus* (Krempelh.) R. Sant. (Thelotremataceae), *Coenogonium isidiiferum* (Lücking) Lücking (Gyalectaceae), *Echinoplaca gemmifera* Lücking (Gomphillaceae), and several species of *Porina*, e.g. the species producing the *Phyllophiale* disc-like 'isidia' (Trichotheliaceae). The total number of species involved in the production of such diaspores is quite low when referred to the number of strictly foliicolous species but is nevertheless important when compared to corticolous or saxicolous species known to produce them. Indeed, in the Tropics and to our knowledge, only a few, poorly known, corticolous representatives of the Thelotremataceae also form such diaspores. The recently described *Myriotrema parvidiscum* Sipman (SIPMAN 1994: 167) produces disc-like diaspores (here referred to as schizidia), as well as the monotypic and sterile *Byssophytum album* Groenh. (recorded from Indonesia/Java and Papua New Guinea) which most probably also belongs to the Thelotremataceae. In Papua New Guinea, three different chemistries are associated with thalli producing such diaspores, and their taxonomy is currently under study by H. J. M. Sipman (pers. comm.). A corticolous collection so far identified as *Bacidina scutellifera* (Vezda) Vezda is known from the Philippines (Luzon, Laguna prov., Los Baños, Mt Makiling Forest reserve, 370 m, 31 VII 1994, P. Diederich 13174, hb. Diederich): it produces the disc-like isidia typical of *B. scutellifera* but the absence of apothecia precludes any final decision on its identity. The selection pressure to produce such diaspores in foliicolous species is thus quite important and is otherwise also observed in foliicolous liverworts (LÜCKING & LÜCKING 1998).

A similar phenomenon is observed with the production of a byssoid thallus in tropical corticolous species and genera. Indeed, the thallus of the following taxa appears to be very similar although they belong to completely

different groups: *Sagenidiopsis merrotsii* R. W. Rogers & Hafellner (Opegraphales), *Dimerella chiodectonoides* Kalb (Gyalectaceae), *Thelopsis byssoides* Diederich (Ostropales, ? Stictidaceae), *Tania lanosa* Egea et al. (Arthoniales), *Tibellia dimerelloides* Hafellner & Vezda (Bacidiaceae), etc. (see further examples in HAFELLNER & VEZDA 1992).

Distribution and ecology: *Aspidothelium gemmiferum* is so far known only from the type locality, a little-disturbed area of lowland rainforest along the northern coast of Papua New Guinea, where it grows on living leaves of an unidentified dicotyledon in the understory. The locality is extremely rich in foliicolous lichens and several further new species have been discovered in the large collections gathered.

Key to the known foliicolous species of *Aspidothelium*

- 1a Ascospores transversely septate 2
- 1b Ascospores muriform 8

- 2a Thallus with abundant disc-like isidia on the prothallus (Papua New Guinea) *A. gemmiferum* Sérus. & Lücking
- 2b Thallus without such isidia 3

- 3a Perithecial wall paraplectenchymatous, externally with a fine spongioid cover (Tropical America)..... *A. ornatum* Lücking
- 3b Perithecial wall formed by densely intricate hyphae, smooth or with irregular appendages, setae or a disc-like expansion on apical parts.....4

- 4a Perithecia smooth.....5
- 4b Perithecia with irregular appendages, setae or a disc-like expansion on apical parts.....6

- 5a Perithecia egg-shaped or papilliform, pale yellowish; ascospores 80-140 µm long (Tropical America) *A. papillicarpum* Lücking ined.
- 5b Perithecia hemispherical to wart-shaped or subglobose, dark grey; ascospores 50-100 µm long (Tropical America).....
.....*A. geminiscarpum* (Malme) R. Sant.

- 6a Perithecia with a disc-like expansion with smooth or minutely dentate margins, whitish to pinkish or pale grey (pantropical)
..... *A. scutelliscarpum* Lücking
- 6b Perithecia with short appendages or setae, pale yellowish to brownish white 7

- 7a Perithecia with up to 0.3 mm long setae; ascospores with the two median cells often slightly enlarged (Tropical America)
.....*A. arachnoideum* Lücking ined.

- 7b Perithecia with short, up to 0.1 mm long, irregular appendages; ascospores with the two median cells not enlarged (pantropical).....
..... *A. fugiens* (Malme) R. Sant.
- 8a Ascospores with the median cell large and simple (Tropical America/Ecuador)..... *A. mirabile* Lücking
- 8b Ascospores regularly muriform 9
- 9a Perithecia with up to 0.2 mm long setae (Tropical America and Africa)
..... *A. trichothelioides* Sérus. & Vezda
- 9b Perithecia with a disc-like expansion..... 10
- 10a Thallus verrucose; ascospores 35-65 x 13-20 µm (Tropical Asia and Australia)..... *A. verruculosum* R. Sant.
- 10b Thallus smooth; ascospores 40-80 x 15-25 µm (pantropical).....
..... *A. cinerascens* Vain.

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PULVINELLA, A NEW GENUS WITH PROSENCHYMATOUS PROPAGULES

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Abstract: *Pulvinella*, a new genus in the Agonomycetales, is described from dead leaves of *Nolina*, a member of the Agavaceae. The fungus produces caducous, prosenchymatous propagules that are multihyphal in origin. Neither a sexual phase nor an alternative asexual phase is known from nature or from culture.

Key Words: Agonomycetales, *Nolina*, systematics, *Verdipulvinus*

INTRODUCTION

Nolina Michx., a member of the Agavaceae, is a perennial plant with long, fibrous, narrowly linear leaves growing from a thick, often subterranean caudex. Dead, decomposing leaves may remain attached to the caudex for several years. In transection, the leaves have several vascular bundles in each of numerous strands of fibers each of which reach from the upper to the lower epidermis. The fiber strands alternate with strips of parenchyma which surround epidermal clefts in which stomata are located. Firm, greenish, cushion-shaped, fungal structures were discovered on decomposing leaves of *Nolina micrantha* I. M. Johnst. These structures, found on leaf parts where decomposition had progressed considerably, were produced on the surface of mycelium exposed by rupture of the epidermis near stomatal clefts of affected leaves.

MATERIALS AND METHODS

Cultures were obtained by rinsing the cushion-shaped structures 3 times in sterile tap water and placing them on the surface of commercial potato dextrose agar (PDA, Difco) in 100 mm diam Petri plates. Cultures were grown at room temperature. For structural study, freehand sections of the mycelium bearing the pulvinate structures were stained in lactophenol-cotton blue.

TAXONOMY

***Pulvinella* A. W. Ramaley gen. nov.**

Genus ad Agonomycetales pertinens. Mycelium in contextibus plantarum immersum. Ab propagulibus caducis, prosenchymatis, origine multihypha denuo generens. Propagula in superficie mycelio exposito dispersa, loci cupulati reproductivi nulli.

Species typica. *Pulvinella nolinae* A. W. Ramaley

Member of the Agonomycetales. Mycelium immersed in plant tissues. Reproducing by caducous, prosenchymatous propagules of multihyphal origin. Propagules scattered on exposed surface of mycelium, cupulate reproductive loci lacking.

***Pulvinella nolinae* A. W. Ramaley sp. nov.**

FIG. 1-3.

Propagula viridula, sphaeroidea, 50-100 (-125) μm diam, pigmentum viridulum extra involucre cellularum; in vicinia ad maturitatem liberata.

Ex foliis emortuis *Nolina micrantha* I. M. Johnston. "U.S.A. NEW MEXICO: Lincoln Co., Valley of Fires. 27 May 1997, Annette Ramaley 9705A." holotypus UC, 1512945; isotypus BPI, 747286.

Propagules (FIG. 1, 2) greenish, sphaeroid, 50-100 (-125) μm diam, the green pigment external to the cellular envelope (FIG. 3); released to the environment when mature. Distinguishable rind and medullary regions lacking (FIG. 3) though peripheral cells may be closer together than cells in the middle of a propagule.

Propagules are produced on exposed mycelium at the ruptured leaf surface. As with many fungi on *Nolina*, this fungus is visible in the parenchyma around and below the stomatal cleft. The fungus consists only of the mycelium and propagules. The propagule surface usually appears darker than the interior (FIG. 1, 2) because cells at the surface are usually closer together, there may be more pigment surrounding surface cells, and, surface cells die, but the cellular envelopes and pigment remain attached and accumulate at the surface. Neither an alternative asexual phase nor spore production by an associated perfect form has been observed. It is not known how commonly the fungus occurs, or whether it inhabits the caudex as well as decomposing leaf tissue.

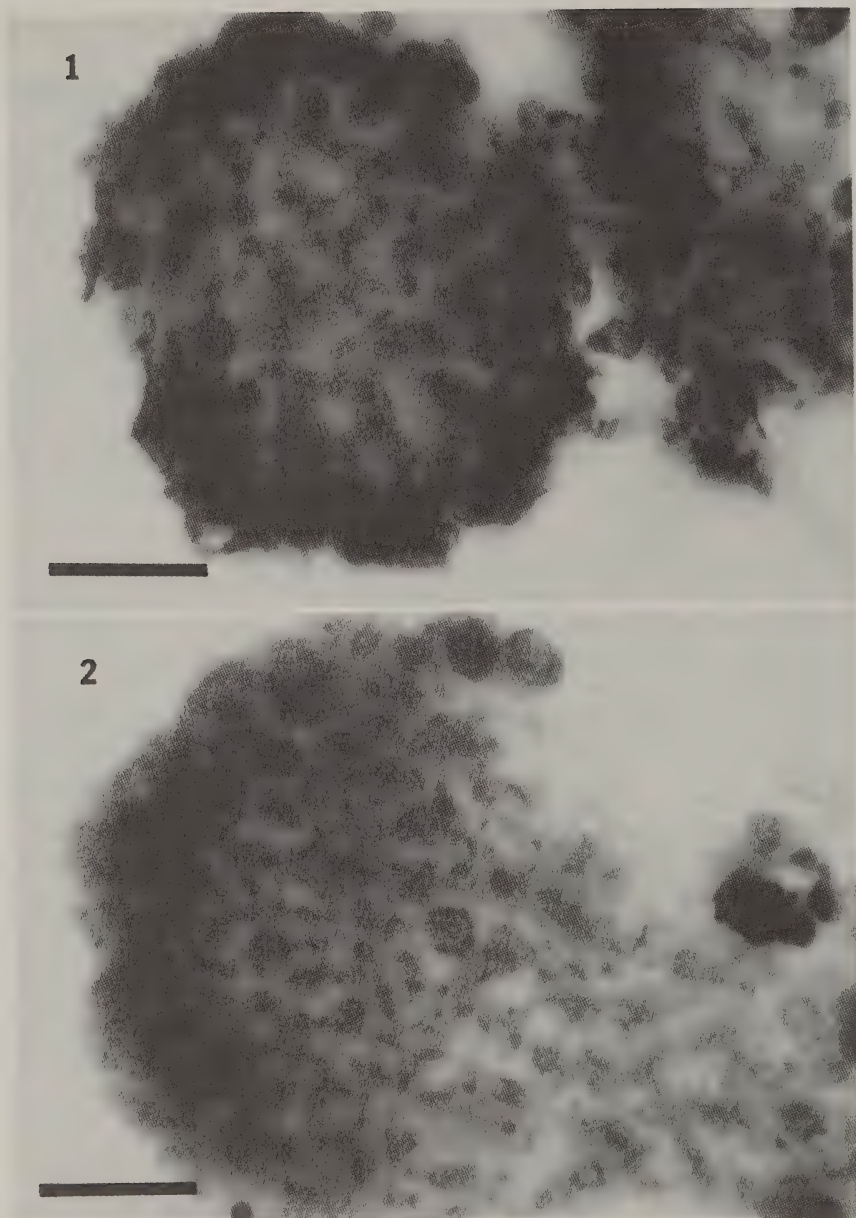
Pulvinella cultures grow slowly and the irregularly shaped colonies never reach the diameter of the 100 mm Petri plate. Pigmentation is variable. Some colonies may appear orange, some may appear purple, or more often, the colonies have areas with both colors. Agar surrounding the colonies is at first bright orange but later becomes purplish orange. A culture has been deposited in the American Type Culture Collection, MYA-771.

DISCUSSION

When *Pulvinella* was first noted it was considered a possible alternative reproductive structure of *Verdipulvinus* (A. W. Ramaley 1999) produced in response to different but undetermined environmental conditions. Propagules of both genera are caducous, discoid to sphaeroid, prosenchymatous, colored green by a pigment that accumulates outside the cell envelope, and of multihyphal origin. Both fungi reproduce in leaves at similar stages of decomposition and sometimes may be found very close to one another. Two differences noted on the host are: (i) *Verdipulvinus* propagules are produced sequentially in cupules at distinct and active reproductive loci. *Pulvinella* lacks cupules, the propagules apparently forming anywhere on the exposed mycelial surface, and (ii) the frequent superposition of *Pulvinella* on other fungal structures—commonly on old ascomata of a *Mycosphaerella*(?) species which extends for great lengths along the stomatal cleft, but also on individual old conidiomata of *Piptarthron*. No such association of *Verdipulvinus* has been noted. However, differences such as these might be expected if the propagules represented alternative imperfect states of the fungus.

Cultures of *Pulvinella* and *Verdipulvinus* derived from propagules formed at nearby sites (< 1 mm distant) on 4 different leaves show some differences. *Pulvinella* propagules germinate within 24 hours of placement on PDA whereas pieces of *Verdipulvinus* discs, similarly treated, require 48 hours for germination. Propagules have never been produced by any *Pulvinella* colonies grown on PDA whereas most *Verdipulvinus* colonies eventually produce stacks of propagules at specialized sites. Cultures of both genera grow at approximately the same rate and attain approximately the same size, but older colonies of *Pulvinella* usually appear purplish, at least in some areas, whereas *Verdipulvinus* colonies are orange. Orange pigment is also present in *Pulvinella* colonies, but is often more or less hidden by the later-appearing purple coloration. These differences under the same growing conditions allowed separation of the genera.

Subicularium Farr & Goos, which S. J. Hughes believed to be synonymous with *Hermatomyces* Speg. (R. D. Goos, personal communication), is a lignicolous tropical genus producing multicellular propagules which may approach the dimensions of the smallest *Pulvinella* propagules. Whereas *Hermatomyces* propagules originate from single hyphae (Hughes 1950), limited material made it impossible to ascertain whether propagules of the specimen described as *Subicularium* were of multihyphal origin or were born as typical conidia on single hyphae. In either case, the genus can be separated from *Pulvinella*. *Subicularium* has mostly superficial mycelium composed of branched, anastomosed hyphae forming a reticulum. Mature propagules are dark brown and composed of more or less isodiametric cells whose outer walls are often thick and blackened. Young propagules are globose to broadly ellipsoid and are pale brown (Farr and Goos 1989). The propagules lack septa in early stages making it unlikely they are of multihyphal origin. None of these conditions is found in *Pulvinella*.



FIGS. 1, 2. *Pulvinella nolinae*. Fig. 1. Stained vertical section of a nearly mature prosenchymatous propagule. Scale bar = 17 μm . Fig. 2. Stained vertical section of a developing propagule. Several hyphae contributing to its formation still connect it to the mycelium. Scale bar = 17 μm .

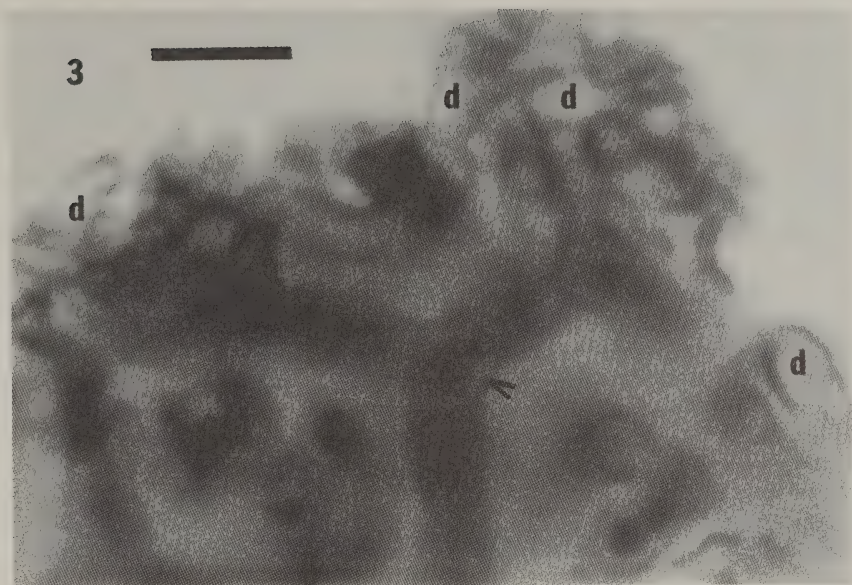


FIG. 3. *Pulvinella nolinae*. Detail of edge of a stained propagule in vertical section. No pseudoparenchymatous rind is present. The pigment (<) lies exterior to the cellular envelope. Dead or dying cells (d) show the cellular envelope and pigment still attached to the propagule. Scale bar = 6 μ m.

Pulvinella propagules can neither be termed conidia nor can they be comfortably placed in any category of vegetative reproductive structures as presently described. Conidia secede by fracture of a single cell or by splitting of a septum. The multihyphal origin of *Pulvinella* propagules renders conidium an inappropriate designation. Use of the term gemma has been rejected in the fungi (Kendrick and Watling 1979). Other existing terms that are possible names for the propagules are bulbil, sclerotium, and sclerotoid body. Weresub and LeClair (1971) distinguished bulbils from sclerotia by: (i) structure: differentiation into rind and medulla in sclerotia and no such differentiation in bulbils; (ii) origin: a gradual gradation from mycelium to sclerotium versus formation of an immediately distinctive unit, a bulbil. *Pulvinella* propagules lack both these characteristics of sclerotia, but like bulbils, the propagules are immediately distinctive units at the surface of the mycelium. However, the structure of mature bulbils is pseudoparenchymatous whereas this tissue is entirely absent in *Pulvinella* propagules. A sclerotoid body (Kendrick and Watling 1979) consists of any 'multicellular resting structures...which cannot...be categorized as bulbils, papulospores or sclerotia.' Such prosenchymatous bodies lack a differentiated rind. I believe these authors tried to keep sclerotoid body an open, catchall term to prevent structures, like those of *Pulvinella*, being forced into some other unsuitable category. *Pulvinella*

propagules conform to this negatively defined category structurally, but the designation ignores the possible differences in origin of the bodies in question and restricts the function to that of 'resting' structures. Whereas sclerotia are often considered to be formed to allow survival under conditions inimical to fungal growth, *Pulvinella* propagules cannot be restricted to this function. Unless the mycelium itself is very resistant, *Pulvinella* propagules may well be 'resting' structures. In addition, since no other reproductive structure is known for this fungus, the structures produced must function directly in reproduction and dispersal as well as resistance to harsh environmental conditions.

Although 'bulbil' and 'sclerotium' are now fairly narrowly defined (Hawksworth *et al* 1995), 'conidium' includes diverse developmental and structural configurations. The major limitation to using this term for *Pulvinella* propagules is the restriction that a conidium be the product of a single cell or hypha. If it is necessary to categorize structures such as *Pulvinella* propagules, it may be best to expand the concept of conidium to include caducous reproductive structures of multihyphal origin. This idea was suggested to me by Dr. Bryce Kendrick in reference to *Verdipulvinus*. Although *Pulvinella* does not produce sequential propagules at specific cup-shaped sites as does *Verdipulvinus*, the characteristics these genera do share would seem to merit their being placed together in whatever category is eventually found suitable.

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My thanks to Dr. Roger Goos for reviewing the manuscript. His helpful suggestions and comments improved the content and are much appreciated. I also thank Dr. Bryce Kendrick for suggesting that prosenchymatous propagules of multihyphal origin might best be considered conidia. The idea was intriguing when it was suggested for propagules of *Verdipulvinus* and even more attractive with the discovery of *Pulvinella*.

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A NEW ANTRODIA SPECIES (CORIOLACEAE, BASIDIOMYCETES)

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SUMMARY: *Antrodia sandaliae* is described as new, based on collections from Sardinia, Italy, growing on *Arbutus unedo*. A key to the European species of *Antrodia* is provided.

Key words: brown-rot polypore, Sardinia.

INTRODUCTION

The genus *Antrodia* P. Karst includes polypores with a dimitic hyphal system, including clamped generative hyphae and hyaline skeletal hyphae and producing a brown rot in the attacked wood. Most species are resupinate with a few being effused

reflexed. Currently 26 species are known from Europe (Ryvarden & Gilbertson 1993, Henrici & Ryvarden 1997). Sardinia has remarkably many endemic and rare polypores such as *Neolentiporus squamosellus* (Bernicchia & Ryvarden) Bernicchia & Ryvarden, *Phellinus juniperinus* Bernicchia & Curreli, *Phellinus rosmarini* Bernicchia and *Lenzitella malenconii* Ryvarden to mention a few. Never the less it came as a surprise when an *Antrodia* specimen from the island did not fit with the description of any of the European species. A search in other available literature (Gilbertson & Ryvarden 1983, Núñez & Ryvarden 2000) gave no clue to its identity and below it is described as a new species.

***Antrodia sandaliae* Bernicchia et Ryvarden sp. nov.**

Etymology: from Sandalia, one of the old Latin names referring to Sardinia, deriving from the shape of the island that resembles a sandalum, the footwear of Roman people.

Carposomata annua, effusa, usque ad aliqua cm lata, resupinata, nodulosa vel aliquando pileata, albicante colore sed paulo post differentia rosei coloris exigua; superficies superior rugosa, margine albo, pubescente. *Pori* plus minusve rotundi, 3-5 pro mm, dissepimentis pubescentibus. *Contextus* tenue, concolore cum superficie poroidea; tubuli unistratosi.

Systema hypharum dimiticum: hyphae generativae numerosae, hyalinae, fibulatae, ramosae, 2.0-3.0 μm latae, tunicis plus minusve tenuibus; hyphae skeletales frequentia pocula, 2.0-5.0 μm latae. Basidiosporae hyalinae, leves, cylindraceae vel subcylindraceae (7.5) 8.0-10.0 x (1.8) 2.0-2.8 (3.0) μm .

Cariem brunneam in ligno *Arbuti* producet.

Holotypus: Italy, Sardinia, Montarbu Forest (Nuoro), m 900 a.s.l., on *Arbutus unedo*, coll. Bernicchia & Ryvarden, 04.XII.2000, herb. HUBO 7348, isotypus in O.

Basidiocarps annual, resupinate to more rarely effused reflexed, 1.5-8.0 x 0.5-3.0 cm wide, soft when fresh; upper surface white

when fresh, cottony soft and azonate, margins sterile, floccose, cottony, white. Pore surface whitish with some pinkish shade, unchanging upon dry; pores round to roundish with some larger ones, 3-5 per mm; dissepiments entire, thick and pubescent. Context very thin and about the same colour as the pore surface.

Hyphal system dimitic: generative hyphae septate, clamped, thin-walled or slightly thick-walled, hyaline, branched, smooth or incrustated, 2.0-5.0 μm in diam, strongly gelatinizing in KOH, exuding an oily floating substance that masks the microscopic observation (the use of Melzer's reagent is suggested), very numerous and dominating in the subhymenium, tubes and context. Some thick-walled hyphae are inflated with a diam of 7.0 μm or have capitate-fusoid ends. Skeletal hyphae very rare, apparently absent, thick-walled, straight, refractive, 2.0-5.5 μm in diam.

Cystidia absent but fusoid cystidioles present.

Basidia clavate, with two to four sterigmata and a basal clamp, 18-20 x 5.0-7.0 μm .

Basidiospores hyaline, thin-walled, smooth, inamyloid and indextrinoid, mostly cylindrical but some having a depression close to the apiculus while a few have a double depression, one close to the proximal end and the other one at the distal part, (7.5) 8.0-10.0 x (1.8) 2.0-2.8 (3.0) μm (Figure 1).

Remarks: *Antrodia sandaliae* resembles *Antrodia infirma* Renvall & Niemelä, a species known only from the boreal North Europe and collected only on dead trunks of *Pinus sylvestris*. Both species have an almost monomitic hyphal system with a dominance of generative hyphae throughout the basidiocarps and both have cylindrical basidiospores. However, those of *A. sandaliae* are longer than the spores of *A. infirma* (Figure 2). While *A. sandaliae* may develop a pileate basidiocarp, this is never the case with *A. infirma*.

A. primaeva Renvall & Niemelä, another boreal species known only from *Pinus sylvestris*, macroscopically resembles *A. sandaliae* as they both may be pileate. However, in *A. sandaliae* the pileus is white and cottony, in *A. primaeva* it becomes brown

and discoloured almost to bay with age. The latter has a trimitic hyphal system with numerous skeletal hyphae and scattered binding hyphae in contrast to the almost monomitic system seen in *A. sandaliae*. Furthermore, the basidiospores of *A. primaeva* are smaller and vary from ellipsoid to subfusiform, while they are cylindrical in *A. sandaliae* (see table 2).

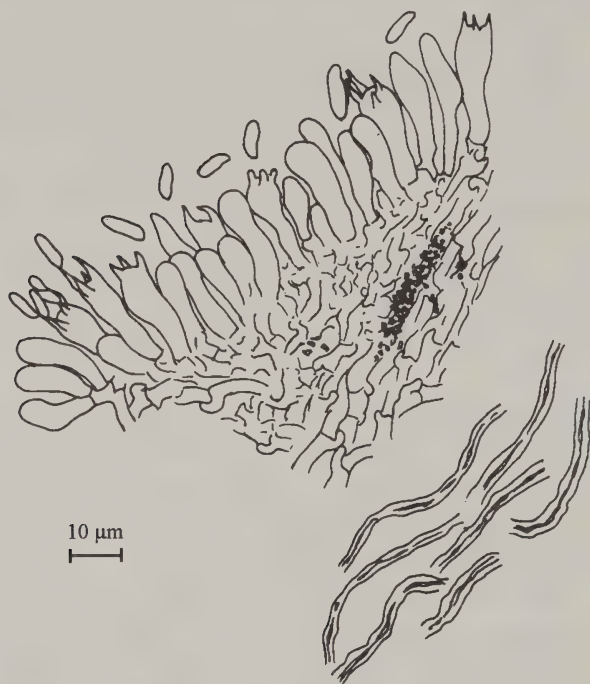


Figure 1 - Microscopical characters for *A. sandaliae*.

Oligoporus rancidus (Bres.) Gilb. & Ryvarden is macroscopically reminiscent of *A. sandaliae* too, but has a monomitic hyphal system and shorter basidiospores.

Specimens examined:

Antrodia sandaliae: Bernicchia (HUBO) 7338, 7339, 7340, 7348, 7350, 7352 from the same locality and substratum.

Antrodia infirma: Finland, Pohjois-Karjala: Lieksa, Patvinsuo National Park, Autiovaara, isotype (O) coll. Reijo Penttilä 1235, 14.IX.1989, on fallen trunk of *Pinus sylvestris*; Finland, Koillismaa prov., Taivalkoski, Metsäkylä, on *Pinus sylvestris*, 17.VIII.1994, coll. J. Nissinen 125; Perä-Pohjola prov., Tervola, Pisavaara Nat. Park, on *Pinus sylvestris*, 29.VII.1979, coll. T. Niemelä 1533 and H. Kotiranta.

Antrodia primaeva: Finland, Kuusamo, Salla, Värriö strict Nature Reserve, 2. Aug. 1988, on dead *Pinus sylvestris*, T. & P. Renvall 316 (O – paratype).

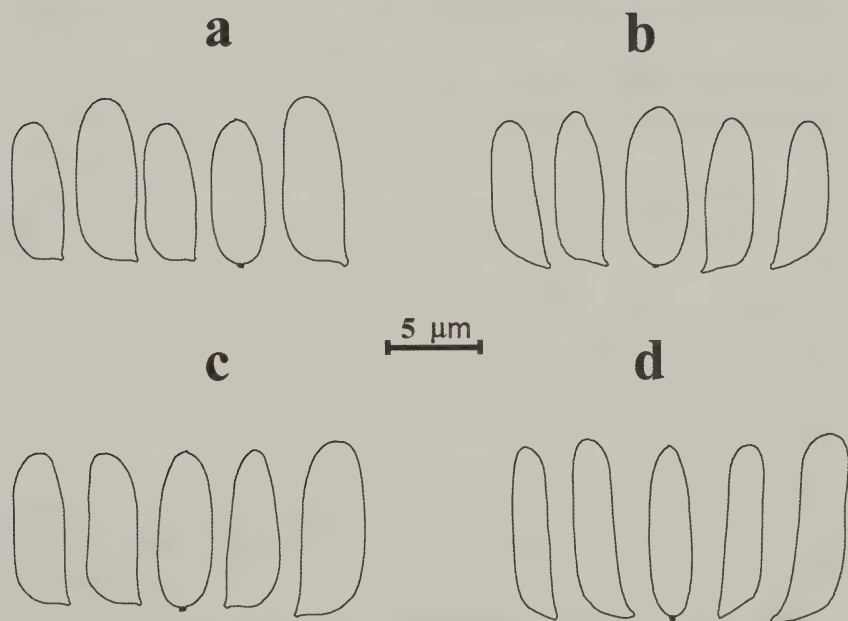


Figure 2: Composite drawing of basidiospores for related species, a) *Antrodia primaeva*, b) *Antrodia infirma*, c) *Antrodia serialis*, d) *Antrodia sandaliae*.

KEY TO EUROPEAN SPECIES OF *ANTRODIA* AND *DIPLOMITOPORUS*

Description of *A. pseudosinuosa* can be found in Henrici & Ryvar den 1997, and all the other European species in Ryvar den & Gilbertson (1993). The letter A refers to *Antrodia*, D to *Diplomitoporus*; a species resembling *Skeletocutis lenis* has been added to the key.

1. Spores generally longer than 7 μm ; all species with pores wider than 1 mm key out here 2
1. Spores generally shorter than 7 μm 13
2. Spores up to 10 μm long 3
2. Spores in average longer than 10 μm 7
3. Pore surface pale brown **A. malicola**
3. Pore surface white, cream to pinkish 4
4. Hyphal system almost monomitic, skeletal hyphae few; basidiocarp fragile 5
4. Hyphal system distinctly dimitic, skeletal hyphae common; basidiocarp tough 6
5. Basidiocarps effused reflexed, pileus white and cottony; basidiospores 8-10 μm long; Mediterranean species found only on *Arbutus unedo* **A. sandaliae**
5. Basidiocarps strictly resupinate; basidiospores 6.3-8.5 μm ; boreal species found only on *Pinus sylvestris* **A. infirma**
6. On gymnosperms; pores 2-3 per mm; basidiospores fusiform; common species **A. serialis**
6. On *Populus* or *Salix*; pores irregular, 1-2 mm wide; spores ellipsoid to subcylindrical; rare boreal species **A. mellita**

7. On deciduous trees 8
7. On gymnosperms 10
8. Spores 9-12 μm long; pores round to angular 2-3 per mm; usually on *Salix* or *Populus* **A. macra**
8. Spores 10-18 μm long; pores angular, 0.5 to 1 mm wide, or sinuous to lamellate and larger; on all types of hardwoods 9
9. Spores 14-18 μm long; basidiocarps resupinate; rare southern species **A. macrospora**
9. Spores 10-14 (-16) μm long; basidiocarps resupinate to pileate; widespread species **A. albida**
10. Parasitic on living *Juniperus* sp.; very rare Mediterranean to tropical species **A. juniperina**
10. Saprotrophic on other gymnosperms 11
11. Pore surface pale to cinnamon brown **A. variiformis**
11. Pore surface white to cream 12
12. Pores 2-4 per mm; basidiospores 6-10 x 2.5-3.3 μm **A. primaeva**
12. Pores 1-2 per mm; basidiospores 9-11 x 4.5-5 μm **A. ramentacea**
13. Spores ellipsoid to subcylindrical 14
13. Spores cylindrical to allantoid 19
14. Basidiocarps brittle when dry; pore surface pale sordid brown to yellow when dry; rhizomorphs usually present 15
14. Basidiocarps hard to soft and cottony when dry; pore surface cream to white when dry; rhizomorphs absent 18
15. Pore surface whitish to pale sordid brown; trama monomitic; spores 5-6 μm long 16

15. Pore surface yellowish; trama dimitic; spores 6-7.5 μm long
A. radiculosa
16. Context and older tubes disintegrated to a white amorphous and crumbly mass 17
16. Context and tubes distinct, easily distinguished 18
17. On Salicaceae, especially *Populus*; cystidioles absent or very few
A. pulvinascens
17. On gymnosperms; pointed cystidioles abundantly present in the hymenium
A. crassa
18. On *Hippophaë*; pores 3-4 per mm; spores 5-6 x 2-3 μm
A. hippophaës
18. On *Populus tremula* or *Fagus*; pores ca. 1 per mm; spores 5.5-7 x 2.8-4 μm
A. mellita
19. Skeletal hyphae strongly to slightly amyloid 20
19. Skeletal hyphae non-amyloid 22
20. Spores allantoid, 1-1.5 μm wide; pore surface white to citric yellow, often cracked in polygons
A. xantha
20. Spores allantoid to cylindrical; pore surface grey, cream to pale sordid brown, not cracked 21
21. Pore surface greyish; skeletal hyphae dissolving in KOH; causing a white rot; pores 3-5 per mm
D. lindbladii
21. Pore surface white or cream to pale sordid brown; skeletal hyphae unchanged in KOH; causing brown rot; pores 5-7 per mm
A. sitchensis
22. Spores 2-3 μm wide 23
22. Spores 1-2 μm wide 25
23. Spores 4-5 μm long; pore surface bright lemon to citric

yellow, purplish red when touched with KOH; known from the Alps **A. alpina**

23. Spores 5-7 μm long; pore surface pale cinnamon to straw-coloured, no red colour with KOH; widespread species 24

24. Basidiocarps resupinate, pore surface cracked, on *Picea* **D. crustulinus**

24. Basidiocarps resupinate to reflexed, pore surface even, on *Pinus* **D. flavescens**

25. Pores 1-3 per mm, irregular, sinuous; dissepiments lacerate 26

25. Pores 3-7 per mm, angular to round; dissepiments entire 27

26. On gymnosperms, basidiocarps resupinate, common species **A. sinuosa**

26. On deciduous trees; basidiocarps pileate, rare species **A. pseudosinuosa**

27. Spores 1.5-2 μm wide 28

27. Spores 1-1.5 μm wide 30

28. Pore surface creamy white to pale sordid brown; skeletal hyphae unchanged in KOH; species with brown rot; usually on *Pinus* 29

28. Pore surface greyish, skeletal hyphae dissolving in KOH and weakly amyloid; widespread species causing a white rot on both hardwoods and conifers **D. lindbladii**

29. Spores allantoid, 5-7 μm long; context distinct and cottony **A. albobrunnea**

29. Spores cylindrical, 4-5 μm long; context indistinct and crumbly **A. sordida**

30. Pore surface cream to citric yellow when fresh, often cracked; spores allantoid; skeletal hyphae weakly amyloid **A. xantha**

30. Pore surface white, soft and even; spores lunate; skeletal hyphae non-amyloid
Skeletocutis lenis

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MUSCODOR ALBUS ANAM. GEN. ET SP. NOV., AN ENDOPHYTE FROM CINNAMOMUM ZEYLANICUM

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ABSTRACT

Muscodor albus, anam. gen. et sp. nov., is described as a deuteromycetous (mycelia sterilia) endophytic species bearing molecular relatedness to the ascomyceteous group *Xylaria*. The fungus is characterized by producing a whitish felt-like mycelium on PDA and other media. Commonly, cultures develop 6-12 erumpent pie shaped sectors radiating from the center of the culture at the original point of inoculation after 4-6 weeks. The hyphae (1.1-1.7 μm dia) grow via right angle branching and commonly intertwine to make rope like strands (3.0-5.0 μm dia) and these can intertwine to make more complex structures. Small mycelial protuberances (1-5 mm in height) arising from older cultures may be pre-stromatal structures bearing no spores. The fungus is related to *Xylariaceae* by virtue of 96-98% homology of its 18S rDNA (2089 bp) to representative members of this group. Furthermore, ITS1, 5.8S, and ITS2 sequences (652 bp) of *M. albus* showed close relatedness to several *Xylaria* spp. including *X. arbuscula*, *X. longipes*, and *X. mali* at the 89-92% level. Under many cultural conditions a musty odor is produced by this fungus.

Keywords: *Xylaria*, mycelia sterilia, 18S rDNA, musty odor

INTRODUCTION

It is estimated that up to 95% of the world's fungi are unknown to science (Hawksworth, 1991; Hawksworth and Rossman, 1997). One of the most likely, relatively unexplored, habitats of novel fungi are the world's rainforests. Fungi can not only be found inhabiting surfaces, but within the organs and tissues of plants. Fungi that exist within the tissues are known as endophytes. However, many endophytes are not reported because most of them produce neither sexual nor asexual reproductive structures in culture including sclerotia and chlamydospores. To some degree this taxonomic problem is now being approached using a novel

technology termed "Phylogenetic Character Mapping" (Mitchell et al., 1995; Guarro et al., 1999; Taylor et al., 1999). The phylogenetic character mapping method involves combining molecular and morphological data with statistical support to assist in fungal identification. The rDNA genes are frequently targeted for fungal taxonomy (Bruns et al., 1991; Guarro et al., 1999; Mitchell et al., 1995) because they are highly conserved regions of molecular information. In addition, the rDNA genes are found in all organisms with a common function evolutionary origin. Finally, the rDNA genes are a non-protein-coding region, and they represent a single nuclear copy that is easy to amplify by PCR techniques. Moreover, several variable regions including spacers between genes evolve at different rates to a point that it is possible to recognize taxa at different ranks (Seifert et al., 1995; Bruns et al., 1991). For example, the nuclear small subunit 18S region has sufficient statistical divergences for studying relationships at or above generic levels whereas the internal transcribed spacers, ITS1 and ITS2, are useful to discriminate relationships near the species level.

In addition to the taxonomic problems associated with fungi that make no fruiting structures is the obvious question as to how such fungi are dispersed from one plant to another. It appears that vertical or seed borne transmission of inoculum can occur from one generation to the next via the germ line, so the need for spore production by the endophyte may not be strictly necessary for maintaining the species (Bayman et al., 1998). Thus, some fungal species may have lost the genetic features essential for spore production since other mechanisms have evolved that allow for the continuation of the species. Certainly, precedence exists for this approach from the work done on many amplified DNA's from ectomycorrhizal fungi from plants that do not match any sequences from fruiting bodies collected at the study site (Reynolds and Taylor, 1993). Therefore, naming DNA-only fungi can be achieved under the present code of Botanical Nomenclature (Reynolds and Taylor, 1993).

In an attempt to find new natural products that have biological activities, we have visited many of the world's rainforests to find endophytic fungi and the products associated with them. In one case we isolated an endophyte that fits the description outlined above; that is, under no conditions in culture has it ever been possible to find any reproductive structures that can serve as tools for a taxonomic description. In a study of the endophytes of a cinnamon tree (*Cinnamomum zeylanicum*), that had been introduced to an area about 30 miles west of La Ceiba, Honduras, in the earlier part of the last century, a sterile endophytic fungus was isolated. Cinnamon, among other plant species, was initially placed in this region of the world in an attempt to find suitable plants to establish an agricultural enterprise in this area of Central America. Eventually, the needed information was obtained and the test area eventually became a park for which fees are now collected for entry. Many of the world's palms, bamboos, bananas, tropical fruit and nut trees are located here. It was in this area that several lower limb pieces of the park's cinnamon tree were sampled and a number of endophytic fungi were obtained. Among these was an extremely musty, odoriferous, whitish, strictly mycelial type fungus. It was of biological and biochemical interest, but it defied a standard taxonomic description. Thus, the objective of this report is to apply both molecular techniques and morphological data to show the evolutionary relationships of this fungus to other fungi and to provide it with a scientific binominal.

MATERIALS AND METHODS

Fungal Isolation

Several small limbs of a mature *C. zeylanicum* tree located 20 miles west of La Ceiba, Honduras, were removed and immediately transported back to Montana State University for processing in the fall of 1997. Small pieces of inner bark, sapwood and outer xylem tissues of the limbs were aseptically removed and placed on Petri plates containing water agar (Strobel et al., 1996). After incubation for several days, hyphal tips of developing fungi were aseptically removed and placed on potato dextrose agar (PDA). In addition, after 7 days, fungal colonies were transferred to gamma irradiated carnation leaves (0.5 x 0.5 cm) to encourage spore production. Of several fungi that were isolated the one of great interest, because of its musty odor, was an isolate designated – “620.”

Scanning Electron Microscopy

In order to do scanning electron microscopy of isolate 620, agar pieces, leaves and other plant parts supporting fungal growth were placed into distilled water with Triton X 100 (wetting agent) and aspirated for 5 min (Strobel et al., 2000). The fungal preparation was then placed into 2% glutaraldehyde in 0.1 M sodium cacodylate buffer (pH 7.2-7.4) and left overnight. The next day they were washed in six 15 min changes of water buffer, followed by three 15 min changes in 10% ethanol, four 15 min changes of 30% ethanol, five 15 min changes of 50% ethanol and left for two days in 70% ethanol. They were then rinsed in five 15 min changes of 95% ethanol and then five 15 min changes in 100% ethanol. The dehydration process was slowly done to discourage the process of hyphal shriveling which occurs during rapid dehydration. Ultimately, the fungal material was critically point dried, gold sputter coated and examined with a JEOL 6100 scanning electron microscope (SEM).

Fungal Growth and Storage

The fungus was also grown on a number of different media including Tryptic Soy Broth Agar (TSBA), Corn Meal Agar (CMA), Malt Agar (MA), Potato Dextrose Agar (PDA) (Difco, Laboratories, Detroit, Mich.). Also the fungus was inoculated on to Petri plates containing water agar with individual samples of small wood shavings of western white pine (*Pinus monticola*), black walnut (*Juglans nigra*), and maple (*Acer saccharum*) as well as bark pieces of *C. zeylanicum* in order to encourage spore production.

In order to determine how to best store isolate 620, several conditions were tried. The fungus was grown on sterilized Whatmann No. 1 filter paper discs that were placed on to the surface of PDA in Petri Plates. The fungus was inoculated as an agar plug in the middle of the filter paper disc on the PDA plate. The plate was incubated for 14 days at 22°C. The paper disc was then removed and placed in a laminar flow hood under sterile conditions for 1 day, or until the paper with its fungal mycelium was dry. The paper disc was then cut into many pieces and stored under various conditions. Also, agar plugs containing the fungus were placed in sterile distilled water and stored at 4°C. In another set of test conditions, mycelial pieces growing on agar were placed in 15% glycerol and stored at -70°C. In each

test, fungal viability was determined by placing the mycelial fragments on to a PDA plate and examining it for fungal growth after 3-4 days.

Fungal DNA Isolation.

For DNA isolation, all fungi were grown in PD broth in 1.5 ml for 18 to 24 h at 23°C. The mycelium was harvested by centrifugation and washed twice with sterile ddH₂O. Total genomic DNA was extracted by the methods of Lee and Taylor (1990).

Amplification of 18S ribosomal DNA.

Partial nucleotide base pair fragments of the 18S rDNA gene from each fungus was amplified via the polymerase chain reaction (PCR) as a single fragment with the primer UK4F (5' CYGGTTGATCCTGCCRG) and UREV (5'GYTACCTTGACGAACTT). PCR was performed in a 50 µl reaction vial containing 0.1 µg genomic DNA, 0.4 µM each primer, 0.16 mM four dNTPs and 5u *Taq* polymerase (Promega) in a buffer of 10 mM tris-HCl (pH 9.0 at 25°C), 50 mM KCl, 3 mM MgCl₂, 0.1% Triton X-100. Amplification was for 30 cycles (45 s at 94.5°C, 45 s at 53.5°C, 90 at 72.5°C).

Amplification of Internal Transcribed Space sequences (ITS) and 5.8S rDNA.

The ITS regions of the test fungus was amplified using PCR and the universal ITS primers ITS5 (5' GGAAGTAAAAGTCGTAACAAGG) and ITS4 (5' TCCTCCGCTTATTGATATGC) (White et al., 1990). PCR was performed in a 50 µl reaction containing 0.1 µg genomic DNA, 0.4 µM each primer, 0.16 mM four dNTPs and 5u *Taq* polymerase (Promega) in a buffer of 10 mM tris-HCl (pH 9.0 at 25°C), 50 mM KCl, 3 mM MgCl₂, and 0.1% Triton X-100. PCR cycling conditions consisted of denaturation at 94°C for 1.5 min, annealing at 55°C for 2.5 min, and extension at 72°C for 3 min for 40 cycles, with a final extension at 72°C for 10 min (Willits and Sherwood, 1999). The PCR products were gel purified and desalted using the QuickStep PCR purification kit (Edge Biosystems).

Cycle Sequencing 18S ribosomal DNA, ITS Regions and 5.8S rDNA.

PCR product (10-40 ng) was sequenced using ABI prism BigDye terminator chemistry (Perkin-Elmer) and the primers shown in Table 1. Sequencing conditions were 25 cycles of 96 for 10 sec, 50 for 5 sec and 60 for 4 min. Isopropanol precipitation was used to purify extension products (Protocol ABI Prism BigDye Terminator Cycle Sequencing Ready Reaction Kit, 1998). The reactions were resolved on an ABI prism 310 Genetic Analyzer (Perkin-Elmer). Nucleotide sequences were determined on both strands with a Sequencer program (Gene Codes Corporation, Inc., 1995).

Table 1. Primers used for determining 18S rDNA and ITS and 5.8S nucleotide sequences of isolation # 620

Primers	Sequences from 5' to 3'
UK4F	5' CYG GTT GAT CCT GCC RG 3'
NE32F1	5' CTG CCC TAT CAA CTT TCG 3'
NE32F2	5' CTC GTA GTT GAA CC T TGG 3'
NE32F3	5' AGA CTA ACT ACT GCG AAA GC 3'
NE32F4	5' GGA TTG ACA GAT TGA GAG C 3'
NE32F5	5' GTA AGC GCA AGT CAT CAG 3'
UREV	5' GYT ACC TTG TTA CGA CTT 3'
NE32R1	5' AGA CCC TGC CAT CGA AAG 3'
NE32R2	5' TTG GAG CTG GAA TTA CCG 3'
NE32R3	5' GCT TTC GCA GTA GTT AGT C 3'
NE32R4	5'GGT CTC GTT CGT TAT CGC 3'
NE32R5	5' AGC ACG ACG GAG TTT AAC 3'
ITS1	5' TCC GTA GGT GAA CCT GCG G 3'
ITS2	5' GCT GCG TTC TTC ATC GAT GC3'
ITS3	5' GCA TCG ATG AAG AAC GCA GC3'
ITS4	5' TCC TCC GCT TAT TGA TAT GC3'
ITS5	5' GGA AGT AAA AGT CGT AAC AAG G3'

Searching and Comparison 18S rDNA and ITS1-2 sequences.

Both 18S rDNA and ITS1-2 sequences of culture collection #620 were submitted to GenBank with serial numbers **AF324337** and **AF324336**, respectively. These sequences were also were searched or compared with other fungal sequences under BLAST 2.1 and a search of NCBI at the web site <http://www.ncbi.nlm.nih.gov/BLAST>. Comparison and alignment sequences were done by using Clustal W version 1.7 (Thomson and Gibson, 1997), and manually aligned afterward.

Maximum parsimony bootstrap method (Felsenstein, 1985) with heuristic search and maximum parsimonious consensus heuristic search were performed using PAUP* (Swofford, 1999). The bootstrap analysis was set as the following: 100 replications, tree bisection-reconnection branch swapping, and random sequence addition. All characters were weighted equally. Reference taxa were *Taphrinales*: *Protomyces inouyei* (GenBank serial number D11377), *Taphrina wiesneri* (D12531), *T. deformans* (U00971) and *T. pruni-subcordatae* (AB000957).

RESULTS AND DISCUSSION

Fungal Taxonomy

Muscodor albus Worapong, Strobel, and W.M. Hess, anam. gen. et sp. nov.

Fungus in natura *Cinnamomo zeylanico consociatus et est deuteromycete myceliis sterilibus pertinens*. *Coloniae fungales* *albidae mediis omnibus temptatis, augmen in scobibus ligni specierum aliquot arborum includens, et sic perpetuo manentes*. *Mycelium* in PDA in 3-4 hebdomadibus patellam tegens et odorem

mucidum validum proprie producens. Culturae vetiores sectionibus cuneiformibus erumpentibus 6-12 loco originis radiantibus et protuberationibus mycelialibus pusillis (1-5 mm alto). Hyphae (1.1-1.7 m dia.) ramificatione in angulis 90° plerumque crescentes, convolubiles et fila funiformia efficientes (3.0-5.0 m dia.).

Telomorpha hujus fungi in Xylariaceis inveniri possit, ob homologiam 96-98% ordinis geneae 18S rDNA (2089 bp) inter hanc speciem et illas familiam in base GenBankea datorum. Data ordia regionis ITS (ITS, 5.8S, et ITS2) Muscodoris albi affinitatem speciebus pluribus Xylariae suggerunt.

Fungus in nature associated with *Cinnamomum zeylanicum* and is a deuteromycete belonging to mycelia sterilia. **Fungal colonies** whitish on all media tested, including growth on wood shavings of several tree species, and remaining so perpetually. **Mycelium** on PDA covering the plate in 3-4 weeks and characteristically producing a strong musty odor. **Older cultures** with 6-12 erumpent, pie-shaped sectors radiating from the point of inoculation, and with small mycelial protuberances (1-5 mm in height). **Hyphae** (1.1-1.7 m dia.) commonly growing by 90° angle branching, intertwining and making rope-like strands (3.0-5.0 m dia.).

The telomorph of this fungus may be found in the Xylariaceae, on account of the 96-98% homology of the 18S rDNA gene sequence (2089 bp) between this species and that family in the GenBank data base. Sequence data of the ITS region (ITS1, 5.8S, ITS2) of *Muscodor albus* suggest a relationship to several *Xylaria* species.

Holotype: Endophytic on *Cinnamomum zeylanicum*. Collections were made about 30 miles west of La Ceiba near La Masica, Honduras, in the botanical garden in this region. The holotype comes from only one *C. zeylanicum* tree. Collected in October, 1997 by Gary Strobel. Dried culture deposited in the Montana State University herbarium (MONT) as *Muscodor albus* isolate 620, 11/20/2000. A living culture is also deposited as *Muscodor albus* in the living MSU mycological collection as **acquisition-2082**. Both 18S rDNA and ITS-2 sequences of *M. albus* have been submitted to GenBank with the assigned serial numbers **AF324337** and **AF 324336**, respectively.

Telomorph: unknown

Etymology: The genus name, *Muscodor*, for this fungus is taken from the Latin which means musty. This is consistent with the nature of the odor that is produced by cultures of this fungus. The species name is the Latin - *albus*, for white, the common color of this organism in culture.

Fungal Biology

The fungus produced a white mycelium on the wood chips on numerous plant species and the bark of *C. zeylanicum* as well on agar based media (Fig. 1). Small (1-5 mm) stromata-like protuberances eventually arose, especially in PDA, after 5-6 weeks of incubation (Figs. 2-3). These never developed into true fruiting bodies. Otherwise, no fruiting structures or spores of any kind have been found when the fungus has been incubated on multiple synthetic and natural media containing plant

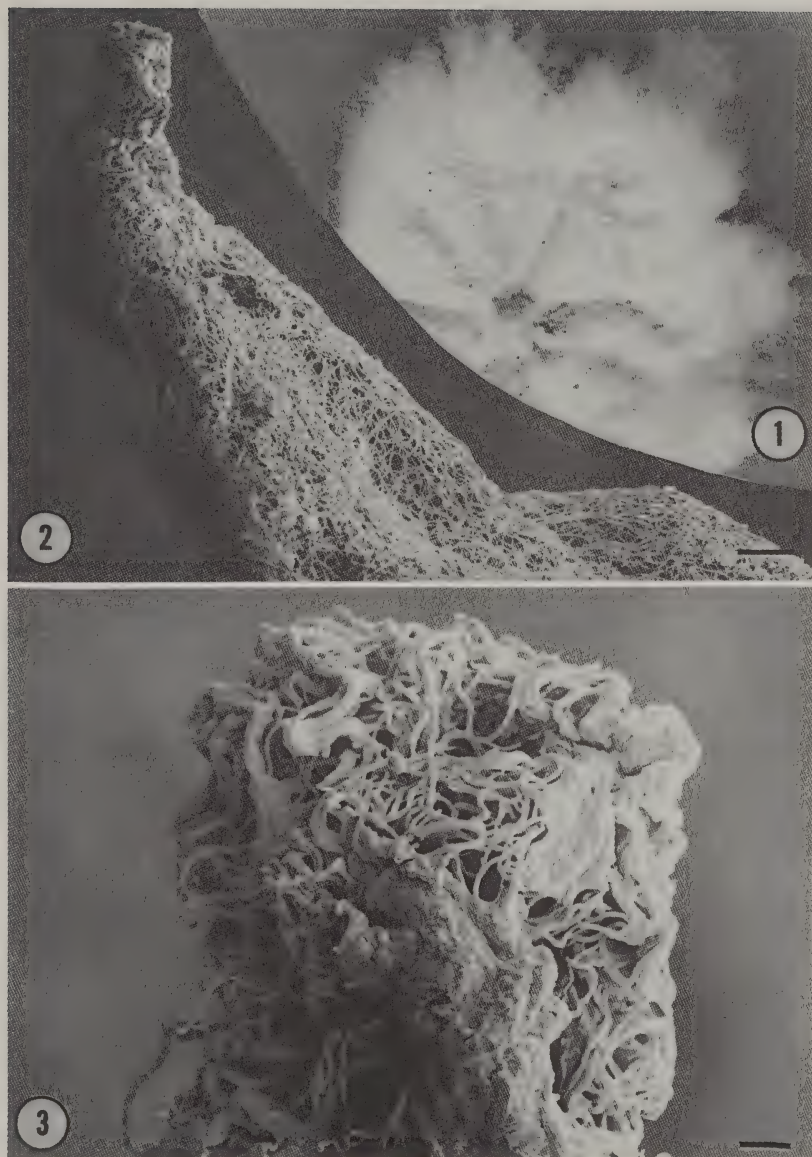


Fig. 1. A 5 week old culture of *M. albus* grown on PDA.

Fig. 2. Scanning electron micrograph of the macroscopically visible protuberance arising from a culture of *M. albus*. Bar=100 μ m.

Fig. 3. Top of the protuberance shown in Figure 2. The hyphae appear to have secreted a substance that has cemented the intertwining hyphae together. Bar=10 μ m.

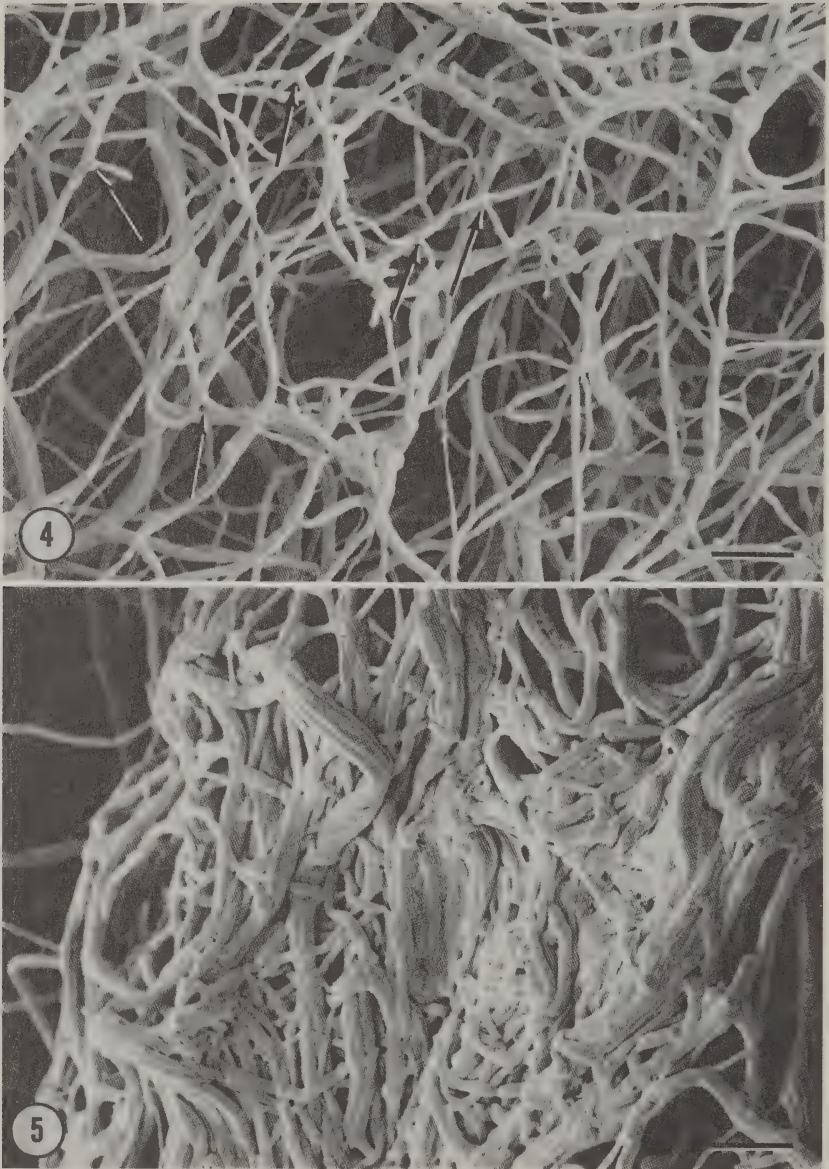


Fig. 4. Scanning electron micrograph of hyphae and mycelium of *M. albus* 1736. Please note numerous examples of right or nearly right angle branching (arrows). Bar=10 μ m.

Fig. 5. Scanning electron micrograph showing the twisted strands of the hyphae of *M. albus* that have further intertwined to make a mycelial mat that is tightly compressed. Bar=10 μ m.

extracts or the wood shavings of various plant species for extended periods (4-6 months). Hyphae tended to tightly intertwine making structures that appeared rope or cable-like. Hyphal branching mostly seemed to occur at right angles (Fig. 4) and tends to have twisting strands of hyphae in older cultures (Fig. 5). The fungus remained viable for at least 5 months having been originally grown on filter paper discs and then placed under storage conditions eg. 22°C, 4°C, 0°C and -70°C. The fungus also remained viable, but to a reduced degree when stored at 4°C in distilled water blanks for up to three years. It also remained viable in 15% glycerol/water when stored at 70°C. There appears to be few of the common characteristics used in fungal morphology to distinguish this fungus from others. Therefore, other molecular characters have been studied.

The unique musty odor of the cultures becomes apparent after 1-2 weeks of incubation. Then, as the mycelium spreads to the entire plate, the odor diminishes. This may occur as the fungus exhausts the nutrients available to it. Although other fungi produce low concentrations of volatile substances, some of the volatile substances of *M. albus* may occur in other fungi (Bjurman and Kristensson, 1992). On the other hand, other compounds seem to be unique for one species (Schnürer et al., 1999). It is typical that the volatile compounds produced by a fungus may be responsible for a distinctive odor, such as a garlic, spicy, musty, or an unpleasant smell (Rapior et al., 2000). The volatile compounds produced by a fungus can be analyzed by GC/MS. Comparisons with the mass spectrum and retention times to authentic reference materials may help with the identification of the responsible compound (Schnürer et al., 1999). In a recent study, *Aspergillus versicolor* was isolated from several mold affected houses and the gas produced by the fungus was analyzed by GC/MS. It was learned that *Aspergillus versicolor* produced ethylhexanol that correlated with the pungent odor in the cultures (Bjurman and Kristensson, 1992). Another study reported that the *fenugreek* odor of *Lactarius helvus* was due to a volatile furanone derivative, sotolon (Rapior et al., 2000). In the case of the musty odor of *M. albus*, initial GC/MS data have shown the presence of at least 26 volatile compounds and their identities and biological activities will be reported elsewhere.

Molecular Biology of *Muscodora albus*

It has been well demonstrated that the molecular characteristics of an organism are unique to it and it can be used to help in classification. One of the most conserved and yet molecularly distinguishing features of an organism is its 18S rDNA and the ITS-1&2 sequences. These partial sequences were obtained from *M. albus* and compared with data in Genbank. After searching partial 18S rDNA sequences, 2089 bp of *M. albus* were submitted to an advanced blast search. The results showed 97, 97, 98, 97, 96 and 96% identities with 3032 bp of *Xylaria polymorpha* (AB014043), 1773 bp. of *Hypoxylon fragiforme* (AB014046), 1715 bp. *Poronia punctata* (AF064052), 2590 bp. of *Rosellinia necatrix*, 2590 bp. of *X. carpophila*, and *Daldinia concentrica* (DCU32402), respectively.

Comparative analysis of the partial ITS 1&2 and 5.8S rDNA sequences of *M. albus* hit ITS 1 and 2 of *X. arbuscula* CBS 452.63 (AF163029) and CBS 454.63 (AF163028), *X. longipes* CBS 148.73 (AF163038), *X. mali* CBS 385.35 (AF163040), *X. cornu-damae* CBS 724.69 (AF163031), *X. hypoxylon* 499.80

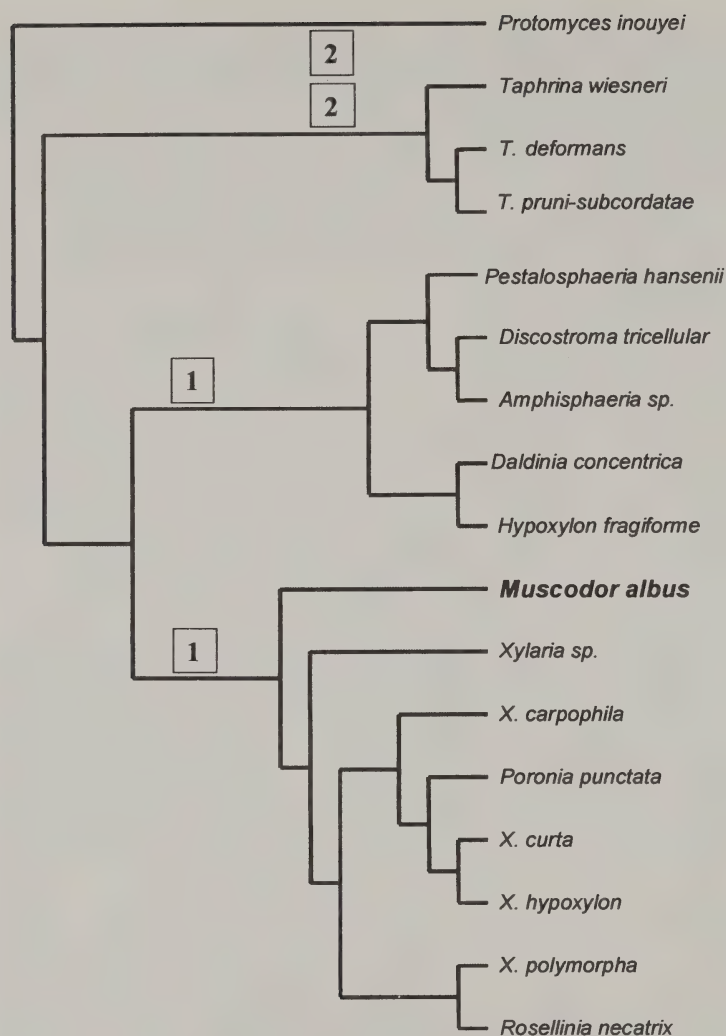


Fig. 6. Strict consensus of 6 equally most parsimonious heuristic search cladograms containing 13 taxa of *Xylariales* (1) and 4 taxa of *Taphrinales* (2). The designated outgroup is *Taphrinales*.

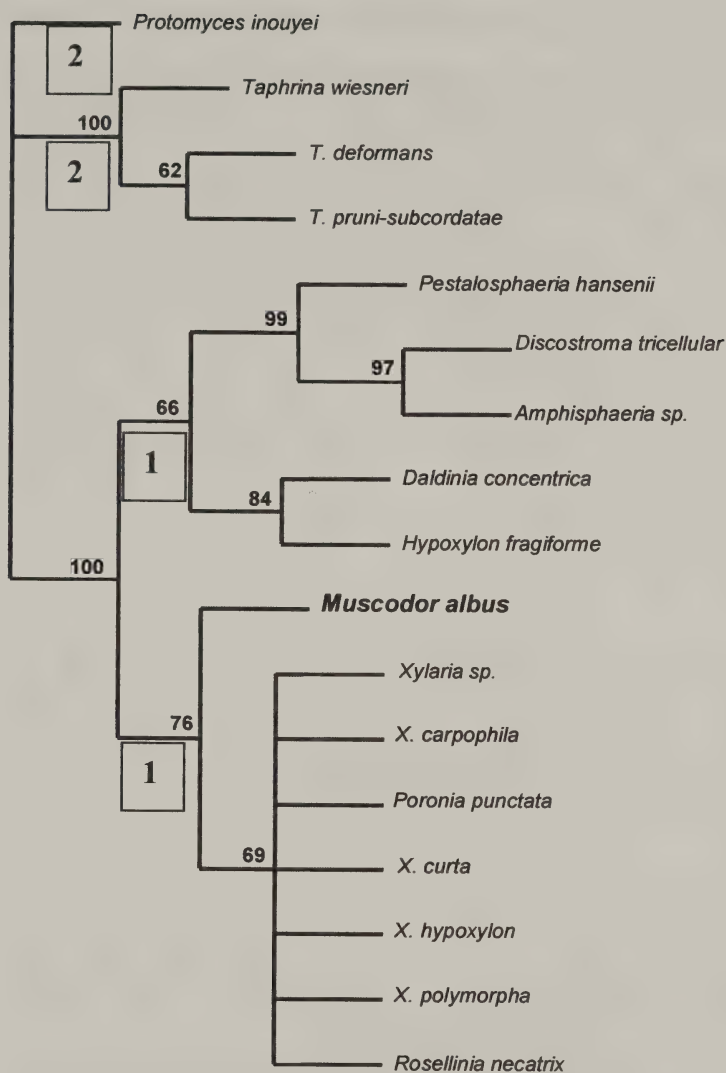


Fig. 7. Maximum Parsimony phenogram of 18S rDNA sequences of *Xylariales* (1) and *Taphrinales* (2) as an outgroup. Bootstrap confidence measures greater than 50% from 100 replications are indicated at internodes.

(AF163035) at 92, 91, 91, 90 and 89% homologies, respectively. No total identities were found.

Overall it appears, based on phylogenetic analysis and comparisons of 18S rDNA sequences of *M. albus* to sequences of *Xylariales* in the Genbank that it is more closely related to the *Xylariaceae* eg. *Xylaria*, *Poronia* and *Rosellinia* than *Amphisphaeriaceae* eg. *Pestalotia* *hansenii*, *Discostroma* *tricellular* and *Amphisphaeria* *sp.* with bootstrap confidence measured at greater than 50% from 100 replications (Figs. 6 & 7). Also, given the fact that the both the 18S rDNA and the ITS 1&2 5.8 S rDNA are unique, this may be added molecular justification that *M. albus* should be considered a taxonomically distinct genus and species. Although, Reynolds and Taylor (1993) suggest that, given the strength of molecular technology, it should be possible to name a DNA-only fungus on the basis of its closest neighbor on the genetic tree. Convention, however, may dictate that such a practice may not be acceptable since its usurps an accepted name without providing a proper morphological basis for use of the same name. Therefore, even though isolate 620 best fits the molecular profile of the *Xylariales*, science may be better served by the placement of a totally new binominal on this organism, thus--*Muscodor albus*. Further chemical and spectral analyses of the volatile gasses produced by this fungus should provide added evidence for its uniqueness.

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HISTERIDOMYCES TISHECHKINII SP. NOV., A NEW SPECIES OF LABOULBENIALES (ASCOMYCETES) FROM NEW ZEALAND

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Abstract: A new species of the genus *Histeridomyces*, *H. tishechkinii*, is formally described and illustrated. Thalli were found on various body parts of *Parepieus* sp. (Coleoptera, Histeridae, Tribalinae) from New Zealand. The new species is compared to other known species of *Histeridomyces* on the basis of morphology, host relationships, and geographical distribution.

Keywords: fungi, *Histeridae*, New Zealand

Introduction

Beetles belonging to the family Histeridae are usually readily recognizable by the strongly-convex, oval bodies and the hard, generally shiny, exoskeleton of the adult stage. Histerids are probably all carnivores, preying on mites, insect larvae, and primitive insects inhabiting dung, carrion, decaying vegetable matter and sub-cortical microhabitats.

The Laboulbeniales known to parasitize beetles belonging to this family are few in number. To date representatives of only four genera of these ascomycete fungi; *Histeridomyces* Thaxt., (Thaxter, 1931); *Homaromyces* R. K. Benj., (Benjamin, 1955); *Laboulbenia* Mont. & C. P. Rob., (Robin, 1853); and *Rhipidiomyces* Thaxt., (Thaxter, 1931), have been reported on hosts belonging to the genera *Aeletes* (as *Acritus*), (Abraeinae, Acritini) *Epierus*, (Tribalinae) *Eubrachim*, (Abraeinae, Plegaderini), *Plagiogramma* (as *Epierus*) (Tribalinae), and *Sternocoelopsis*, (Hetaeriinae), with an additional, doubtful, report on *Margarinotus* (Histerinae, Histerini) (Stadelmann & Poelt, 1962).

Histeridomyces, the subject of this study, includes five described species: *H. acriti* Thaxt. described on *Aeletes* (as *Acritus*) sp. nr. *simpliculus* de Marseul from Barro Colorado Island, Panama (Thaxter, 1931); *H. europaeus* W. Rossi described on *Eubrachim hispidulus* (Bremi-

Wolf) (as *E. pusillus* Rossi) from Italy (Rossi, 1980); *H. flagelliferus* Thaxt. described on *Plagiogramma incus* de Marseul from Venezuela (Thaxter, 1931); *H. ramosus* Thaxt. described on *Epierus lucidulus* Erichson and another undetermined species of *Epierus* from Venezuela (Thaxter, 1931); and *H. venezolanus* Thaxt. described on *P. incus* (as *Epierus*) from Venezuela (Thaxter, 1931). None of these species have been re-collected following their initial description. The purpose of this study is to describe a new species of *Histeridomyces*, *H. tishechkinii* found parasitizing a species in the genus *Parepierus* H. Bickhardt (Tribalinae) from New Zealand. This collection greatly expands the known distribution of the genus *Histeridomyces* as all previous reports have been from tropical Central and South America, and Southern Europe.

Materials and Methods

Host insects were collected using standard entomological techniques by R.A.B. Leschen (New Zealand Arthropod Collection- NZAC), and C. E. Carlton (Louisiana State Arthropod Museum). Collected insects were stored in 70% ethanol for transport to the laboratory. For making microscopic observations, fungi were mounted in glycerol in accordance with the techniques outlined by Benjamin (1971, 1986). The holotype of the newly described species is deposited in the New Zealand Fungus Collection (PDD) with isotypes in the Mycological Herbarium at the institutional address of the author (SYRF).

Taxonomy and Results

Histeridomyces tishechkinii A.Weir sp. nov.

Fungus hyalinus, repens ac expansus. Longitudo a pede usque ad perithecii apicem 135-195 µm. Receptaculi basalis cellula longior quam latior, ad rotundatum pedem decrescens. Cellula II quadriangula aut latior quam longior; cellula III quadriangula aut applanata, primum axem et duos oppositos, secundarios axes sufferens. Primus axes 4-5 superpositis cellulis gradatim longioribus ac tenuioribus constans. Secundarii axes elongati, divergentes, repetite divisi. Perithecium singulum, aequale, ellipticum aut ovoideum, contracto apice 4 brevibus labiis praedito; perithecii stirps 4-5 superpositis quadriangulis cellulis constans. Antheridia solitaria, ampulliformia, ex secundariis appendicis orientia. Parasitus *Parepieri* sp. in Nova Zeelandia.

Ascoma hyaline, with generally repent, spreading, habit. Total length from foot to tip of perithecium 135-195 µm. *Receptacle* basal cell (I) 15-20 x 10 µm, longer than broad, tapering below to the inflated, circular, black foot. In many specimens the foot appears to be intercalary with resultant axes arising in 2 directions. Cell II 10 x 5-8 µm quadrate to broader than long, giving way distally to a third, quadrate to flattened, superposed cell that typically forms secondary axes branching left and right, in addition to supporting the erect primary axis. In some specimens there may be repeated divisions of cell II forming a lower receptacle of

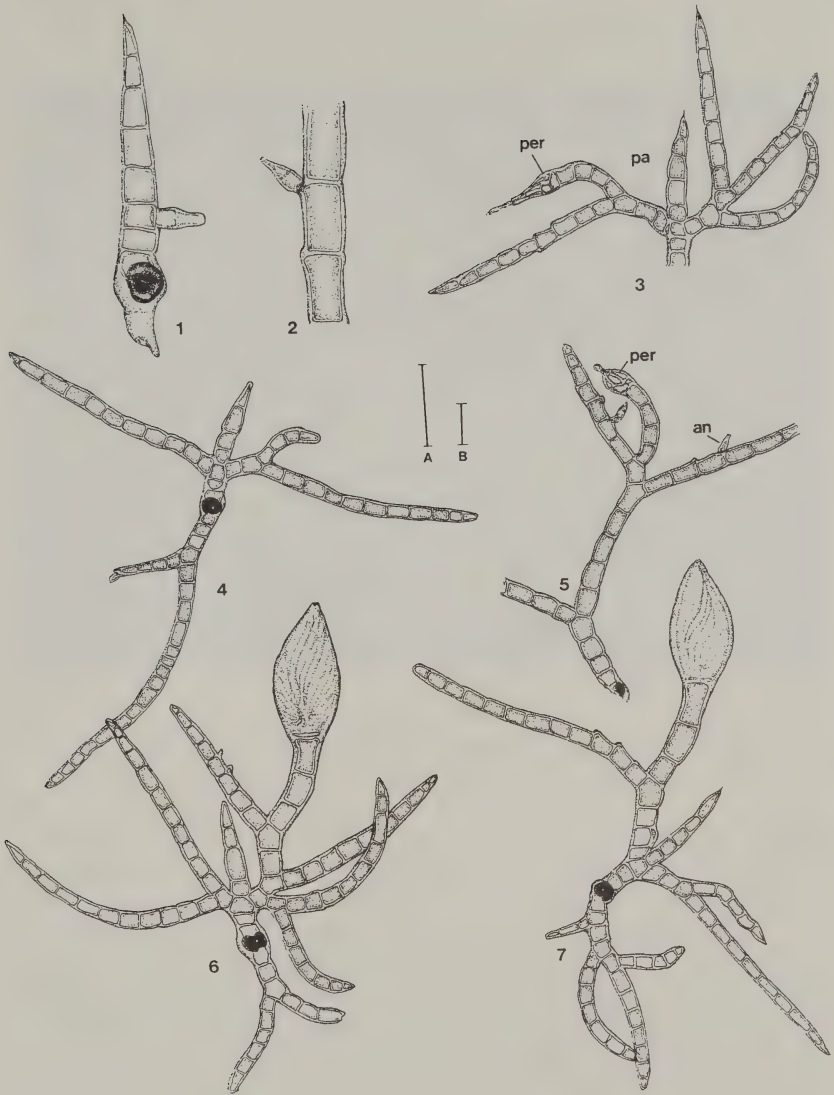


Fig. 1. Immature stage with well developed foot cell and outgrowth from cell II initiating the secondary receptacle 2. Antheridial branch with distinct flask shaped antheridium 3. Immature thallus with developing perithecial development (per) and primary appendage (pa) 4. Immature thallus lacking perithecial development 5. Immature thallus with developing perithecial development (per) and antheridia (an) 6-7 Mature thalli with antheridial scars (an) Scale Bars = 20 μ m. Figs 1, 2 = Scale Bar A; Figs 3-7 = Scale Bar B.

superposed cells. Primary axis usually consisting of 4-5 additional, superposed cells, which become gradually longer and narrower distally, the terminal cell spinose. Secondary axes long, divergent, branched 1-3 times with differentiated accessory appendages associated with the development of each perithecium. *Perithecium* typically only one per thallus, 50-75 x 20-40 μm , symmetrical, elliptical to ovoid, tapering abruptly to a narrow apex with 4 short lip cells. Perithecial basal cells small and hardly distinguished. Perithecium with 4 cells of unequal height in each vertical row of outer wall cells. Stalk cell multicellular, consisting of a superposed series of 3-4 quadrate to rectangular cells. Trichogyne a simple filament. *Antheridia* 10 x 5 μm simple, stout, flask-shaped, solitary and borne from cells of the accessory appendages on the secondary axes.

HOLOTYPE: New Zealand: South Island; Otago Lakes District, 17km NW Glenorchy, on the elytra, abdomen, and legs of *Parepieus* sp. (Coleoptera, Histeridae), under bark of rotten log, 28 Jan. 1999, leg. R. A. B. Leschen and C. Carlton, PDD 72040

ISOTYPES: same collection data as above, in coll. SYRF (AW-844).

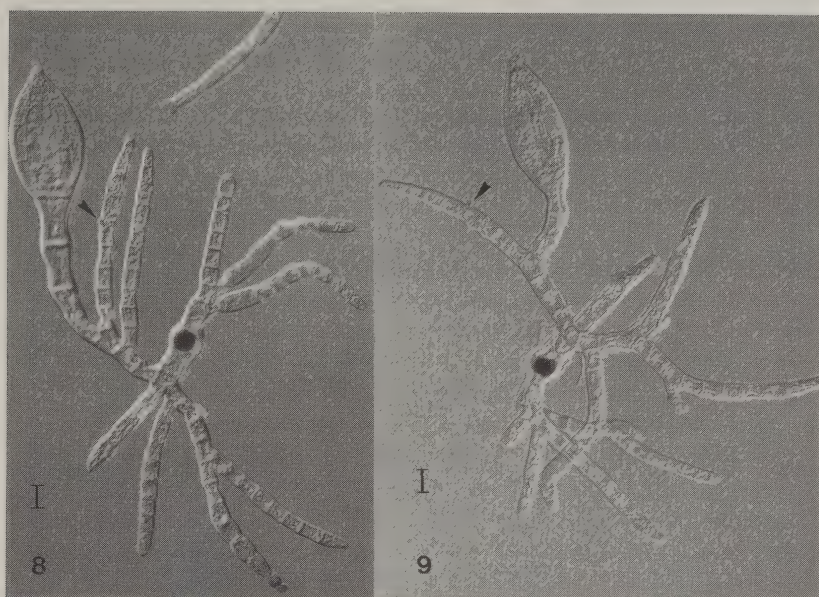
Etym.: This new species is named for Alexey Tishechkini, student of the Histeridae, who identified the host on which this fungus was found.

H. tishechkinii differs from *H. acriti* and *H. venezolanus* in its more repent habit, the production of single, non-terminal, antheridia from cells of the accessory appendages, and in the size and shape of the perithecium.

The new species also differs from *H. ramosus* and *H. flagelliferus* in the lack of terminally-produced antheridia and in the distinctly intercalary development of the foot.

Based on gross morphology, *H. tishechkinii* is perhaps most closely allied with *H. europaeus*. Both of these taxa have a generally repent habit, and the foot occupies an intercalary position. *H. tishechkinii* differs in typically forming only one perithecium on each thallus, and in lacking the extremely long braches of the secondary axes exhibited by *H. europaeus*. The new species is also unusual within the genus *Histeridomyces* in possessing single, simple antheridia that form directly from cells of the accessory appendages. It is uncertain whether or not this character is present in *H. europaeus* since no structures undoubtedly referable to antheridia were observed in any of the many specimens observed by Rossi (1980).

The two recognized subfamilies of Histeridae known as hosts of *Histeridomyces* spp., *Abraeinae* and *Tribalinae*, are thought to be only distantly related, with members of *Tribalinae* being basal and *Abraeinae* more advanced (Slipinski and Mazur, 1999). It is of some interest, therefore, that these subfamilies share obviously closely-related parasites, with the presumed nearest relative of the newly described parasite species *H. tishechkinii* occurring on a host



Figs 8-9 Mature thalli with antheridial scars (arrowheads).
Scale Bars = 10 μ m

currently classified in a different sub-family. Bearing in mind the habitat preferences of all of the known hosts of *Histeridomyces* for subcortical space in dead wood it seems likely that the pattern of occurrence of Laboulbeniales parasites on Histeridae has more to do with shared habitat characteristics than with host taxonomy. Unlike the patterns of host utilization reported in the Staphylinidae (Frank, 1982), the patterns observed in Histeridae may, thus, not be a good indicator of phylogenetic history.

Acknowledgments

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PERONOSCLEROSPORA ERIOCHLOAE SP. NOV. AND OTHER DOWNY MILDEWS ON NATIVE GRASSES IN QUEENSLAND, AUSTRALIA

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ABSTRACT

A new species of downy mildew, *Peronosclerospora eriochloae*, found on *Eriochloa pseudoacrotricha*, is described and illustrated. The morphology and taxonomic status of *Peronosclerospora noblei*, found only on *Sorghum leiocladum* in Australia are discussed. Both downy mildews are systemic within their hosts, the asexual and sexual states developing on vegetative tillers which have more nodes and wider leaves than healthy flowering tillers. The morphology of the sexual states of unidentified downy mildews on three other wild grasses, known only from herbarium material, is also given.

Keywords: *Peronosclerospora noblei*, downy mildew

INTRODUCTION

Three of the nine downy mildews that have been recorded on grasses in Queensland, Australia (Table 1), namely *Peronosclerospora maydis* (Racib.) C.G. Shaw, *Peronosclerospora sacchari* (Miyake) Shirai & Hara, and *Sclerophthora macrospora* (Sacc.) Thirum., C.G. Shaw & Naras., cause serious losses of cultivated annual grasses, eg., maize (*Zea mays* L.), sorghum [*Sorghum bicolor* (L.) Moench] and sugarcane (*Saccharum officinarum* L.) in several countries. According to distribution maps published in Commonwealth Mycological Institute (1988) and in Bock and Jeger (1996), *Peronosclerospora sorghi* (Weston & Uppal) C.G. Shaw has also been recorded in Queensland. However, these records are incorrect because specimens of a downy mildew on maize which were tentatively identified as *P. sorghi* at the Commonwealth Mycological Institute were reexamined and considered to be *P. maydis* (Stamps, pers. com.). Ramsey and Jones (1988) confirmed the identity of this downy mildew as *P. maydis*.

During a study of systemic diseases of subtropical grasses in southern Queensland, Australia, downy mildews were found on *Sorghum leiocladum* (Hack.) Hubb. (wild sorghum) and *Eriochloa pseudoacrotricha* (Stapf ex Thell.) J.M. Black (early spring grass). Langdon (1950) had already recorded *Sclerospora noblei* Weston [= *Peronosclerospora noblei* (Weston) C.G. Shaw] on *S. leiocladum* at Hirstglen in

[= *Peronosclerospora noblei* (Weston) C.G. Shaw] on *S. leiocladum* at Hirstglen in southern Queensland. That downy mildew was described by Weston (1929, 1942) from material collected in the Glen Innes district of northern New South Wales. In the United States, Kubicek and Kenneth (1984) gave a brief description of the first downy mildew recorded on *Eriochloa* spp., which they tentatively named *Peronosclerospora globosa*. However, that name has never been validly published. The downy mildew on *Eriochloa* in Australia has characteristics which distinguish it from *P. globosa*, and is here described as a new species.

The *Sclerospora* species on *Eragrostis* sp., *Sorghum plumosum* (R.Br.) Beauv. and *Triodia pungens* R.Br. in Queensland are known only from herbarium specimens which consist of frayed leaves containing oogonia. This paper presents data on the morphology of the downy mildews on *S. leiocladum* and *E. pseudoacrotricha* from studies on living plants, and on *Eragrostis* sp., *S. plumosum* and *T. pungens* from herbarium material. The taxonomic status of these downy mildews is also discussed.

Table 1. Graminicolous downy mildews recorded in Queensland

Pathogen	Host ¹	Reference
<i>Peronosclerospora</i> (Ito)		
Shirai & Hara		
<i>eriochloae</i> sp. nov.	<i>Eriochloa pseudoacrotricha</i>	Present report
<i>maydis</i>	<i>Sorghum plumosum</i>	Ramsey and Jones (1988)
	<i>Zea mays</i>	Ramsey and Jones (1988)
<i>noblei</i>	<i>Sorghum leiocladum</i>	Langdon (1950); present report
<i>sacchari</i>	<i>Saccharum officinarum</i>	Leece (1941)
sp.	<i>Zea mays</i>	Unpublished ²
<i>Sclerophthora</i> Thirum., C.G. Shaw & Naras.		
<i>macrospora</i>	<i>Axonopus compressus</i> (Sw.) P. Beauv.	Steindl (1957)
	<i>Brachiaria mutica</i> (Forssk.) Stapf	Steindl (1957)
	<i>Digitaria ciliaris</i> (Retz) Koeler	Steindl (1957)
	<i>Panicum maximum</i> Jacq.	Steindl (1953)
	<i>Pennisetum purpureum</i> Schumacher	Steindl (1953)
	<i>Saccharum officinarum</i>	Steindl and Smith (1952)
	<i>Sorghum bicolor</i>	Unpublished ²
	<i>Sorghum verticilliflorum</i> (Steudel) Stapf	Steindl and Smith (1952)
	<i>Zea mays</i>	Unpublished ²
<i>Sclerospora</i> (Schrot.) de Bary		
sp.	<i>Eragrostis</i> sp.	Simmonds (1966)
sp.	<i>Sorghum plumosum</i>	Unpublished ²
sp.	<i>Triodia pungens</i>	Unpublished ²

¹ All hosts, other than *Sorghum bicolor* and *Zea mays*, are perennial

² Unpublished records; specimens held in BRIP

THE QUEENSLAND DOWNY MILDEWS

1. *Peronosclerospora eriochloae* Ryley & Langdon sp. nov. on *Eriochloa pseudoacrotricha*

Mycelium hyalinum, non-septatum; **oogoniis** luteolis, globosis vel subglobosis levis, 33-(46.6 $\pm$ 6.4)-70 μ m diameter; parietes oogonialis, hyalini, 1.0-1.5 μ m crass, confluentes cum pariete oosporis; **oosporii**, hyalini, globosis, 27-(33.5 $\pm$ 3.1)-46 μ m diameter, germinatione oosporae nondum visa; pariete oosporis bistratus, exosporium rubro-brunneum, 2-15 μ m crassa, endosporium hyalinum, 2-3 μ m crassa; **conidiophores** erectis, 2-4 dichotomo-ramosis, 245-280 μ m altis, 45-100 μ m ad locum latissimum, sterigmatibus coniodo-subulatis, 4-9 μ m longis, 3-4 μ m crassa; **conidiis** globosis vel subglobosis, hyalinis, paries unitunicatus, sine operculo vel poro, 9-(13.3 $\pm$ 1.1)-18 x 9-(12.0 $\pm$ 1.4)-12 μ m, semper germinantia per germinationis tubos.

Hospes: *Eriochloa pseudoacrotricha*: Allora, Queensland, 31.iii.1979, M.J. Ryley (BRIP 13691); Esk, Queensland, 1.iv.1979, M.J. Ryley (BRIP 13692); Upper Pilton, Queensland, 9.iv.1979, M.J. Ryley (HOLOTYPUS: BRIP 13693).

Mycelium hyaline, nonseptate. **Oogonia** orange to luteus (Rayner, 1970), globose to subglobose, 33-(46.6 $\pm$ 6.4)-70 μ m in diameter. Oogonium wall hyaline, 1.0-1.5 μ m thick, confluent with oospore wall. **Oospores**, one per oogonium, hyaline and globose, 27-(33.5 $\pm$ 3.1)-46 μ m in diameter. Oospore germination not observed. Oospore wall of two layers, a reddish-brown exosporium 2-15 μ m thick, and the hyaline endosporium 2-3 μ m thick. **Conidiophores** emerge through stomata from hyphae in the substomatal cavities reaching a total length of 245-280 μ m. Main axis of conidiophore swollen at the base (6-13 μ m in diameter), gradually decreasing in diameter to 6-9 μ m wide at a septum, 90-115 μ m from the base. Above the septum the axis diameter increases to 20-30 μ m at the start of the branches. Branching system dichotomous, with secondary, tertiary and quaternary branches, 45-100 μ m wide. Sterigmata at tips of branches, conoid-subulate, 4-9 μ m long, 3-4 μ m wide. **Conidia** globose - subglobose, hyaline, without operculum or pore, 9-(13.3 $\pm$ 1.1)-18 x 9-(12.0 $\pm$ 1.4)-12 μ m, germinating by one or two germ tubes. The asexual and sexual states of *P. eriochloae* are illustrated in Figure 1.

The dichotomous branching of the conidiophores, iterative germination of conidia, and the morphology of the oogonia places this downy mildew in *Peronosclerospora* (Shaw, 1978). However, the morphological features of the asexual and sexual states of the downy mildew on *Eriochloa pseudoacrotricha* differ from all the recognised *Peronosclerospora* species. It closely resembles *Sclerospora secalina* Naumov in the characteristics of its oogonial state. That downy mildew was described by Naumov (1949) on *Secale cereale* L. on the basis of its sexual state only. The description of *S. secalina* is confusing because the upper limit for the diameter of oospores is greater than the maximum diameter of oogonia, an inconsistency noted by Waterhouse (1964). Shaw (1975) offered the opinion that the material on which *S. secalina* was based was a collection of *Sclerophthora macrospora*, a downy mildew known to infect *S. cereale*.

Kubicek and Kenneth (1984) gave a brief description of a downy mildew which they had found on *Eriochloa contracta* Hitchcock in Texas, USA. It infected *E. contracta*, *Eriochloa crebra* S.T. Blake and *Eriochloa nubica* Stapf, but not sorghum or maize. Conidia were globose, occasionally subglobose, and 12-18 μ m wide, and oospores were 28-36 μ m in diameter, in adherent oogonia 40-54 μ m in diameter. Kubicek and Kenneth considered the downy mildew to be a new species, and named it *Peronosclerospora globosa*. However, this name has never been validly published in accordance with Article 36 of the International Code of Botanical Nomenclature, so it must be considered a *nomem nudum*. In most respects the characteristics of the oospores and conidia of the Texas *Eriochloa* downy mildew are similar to those of the Queensland specimens. Lack of further information prevents a definitive conclusion to

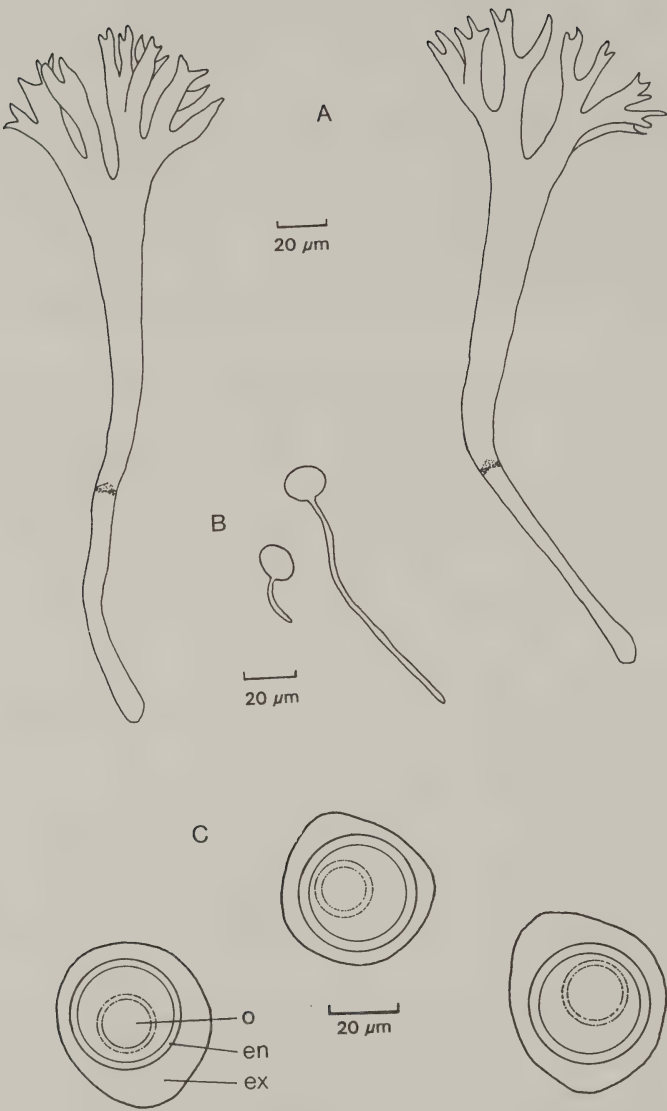


Figure 1. *Peronosclerospora eriochloae*. A conidiophores; B germinating conidia; C oogonia showing exosporium (ex), endosporium (en) and oil globule (o).

be made on the relationship between the *Eriochloa* downy mildews in Queensland and Texas.

Kubicek and Kenneth (1984) made a brief mention of an Australian specimen in their article. They were undoubtedly referring to two specimens of *Peronosclerospora* found on *E. crebra* in New South Wales (see below), because both specimens contain a short note written by Kenneth and dated 9 October 1984. There was profuse asexual sporulation on both leaf surfaces in the specimens, the conidia being subglobose, hyaline and $15\text{--}19 \times 13\text{--}17 \mu\text{m}$. The conidia were broader than those of *P. eriochloae*, so the identity of the New South Wales specimens remain uncertain until fresh specimens, with conidia and oogonia, are examined.

Specimens examined: On *Eriochloa crebra*: Bourke, New South Wales, D. Campbell, 9.ix.1979 (DAR 34156); Bourke, New South Wales, D. Campbell, 30.i.1980 (DAR 35870).

Eriochloa pseudoacrotricha (early spring grass) is a perennial, tussocked grass with winter dormancy in southern Queensland. Tiller production is closely linked to rainfall, with individual tussocks having more than one period of tiller production during its growing season (September to April). *Peronosclerospora eriochloae* survives as hyphae in the tiller bases of its host. There the hyphae are coenocytic, branched, thin-walled, $3\text{--}6 \mu\text{m}$ wide, and are always found intercellularly in the parenchyma near the vascular strands. When tiller buds begin to elongate in response to rain, hyphae grow into some of the buds and not into others. Uninvaded buds developed into healthy, flowering tillers while invaded tiller buds develop into systemically infected tillers. In the field, individual tussocks may be entirely healthy or have both healthy flowering tillers and infected vegetative tillers in varying proportions.

The asexual and sexual reproductive structures of *P. eriochloae* are confined to tillers which differ markedly from healthy flowering tillers. These special tillers are vegetative, there being no development of an inflorescence at the apical growing point. They are approximately equal in height to flowering tillers (mean height 55.3 cm vs 60.8 cm), have more nodes (mean number 6.6 vs 3.8), and bear wide, upright chlorotic leaves (mean width 9.6 mm vs 3.6 mm).

Conidiophores bearing conidia develop from substomatal cavities on both surfaces of chlorotic leaf blades, with sporulation beginning at the leaf tips and extending in a series of steps towards the ligule over time. Soon after infected tillers reach their maximum height the uppermost leaves die and begin to fray from the tips, due to the pressure exerted on the vascular bundles as the oogonia of *P. eriochloae* expand in the interfascicular spaces. The presence of tall tillers bearing necrotic frayed leaves is a dominant feature of the symptom picture in the field during the grass's dormant period.

Infected seedlings have been observed growing in the vicinity of mature infected tussocks at a number of localities in southern Queensland. Symptoms developed when seedlings were 15 cm high, with one or two culms bearing two basal green leaves and one or two wide, partly chlorotic leaves. On the lowermost chlorotic leaf, chlorosis was confined to the basal part of the leaf blade. Conidiophores bearing conidia of *Peronosclerospora eriochloae* only developed on the chlorotic areas of leaf blades.

Fourteen-day-old seedlings of early spring grass which had been grown from surface-sterilised seed were inoculated with conidia of *P. eriochloae* by spraying with a suspension of 1×10^4 conidia/ml. Forty to fifty days after inoculation, tillers bearing wide chlorotic leaves (on which sporulation occurred) developed. The seedlings were

transplanted into garden plots at the University of Queensland, St. Lucia, Queensland, where they grew into large tussocks which produced both healthy and infected tillers over the next two growing seasons.

2. *Peronosclerospora noblei* (Weston) C.G. Shaw on *Sorghum leiocladum*

Sclerospora noblei was described by Weston (1929) on a grass then identified as *Sorghum plumosum*. It was shown by Hubbard (1938) that the grass was distinct from *S. plumosum*, so he named it *Sorghum leiocladum*. It is now known that *Sorghum plumosum* is restricted to the northern tropical parts of Australia, while *S. leiocladum* grows in upland areas of the subtropical and temperate zones of eastern Australia (Vickery, 1961). The original description of *S. noblei* (Weston, 1929) was based on oosporic material collected at Glen Innes, New South Wales and later Weston (1942) described the asexual state from preserved material sent to him by R.J. Noble. Weston (1942) noted that the conidium walls of *S. noblei* lacked a thickened, modified papilla for dehiscence, and that the spores germinated by germ tube(s). He also considered that its characteristics precluded *S. noblei* from any alliance with the sporangium-producing *S. graminicola* (Sacc.) Shröt. On the basis of Weston's observations, Shaw (1980) transferred *S. noblei* to *Peronosclerospora*. The downy mildew has been recorded only in Australia, and on one host, *Sorghum leiocladum*.

The characteristics of *Peronosclerospora noblei* listed below are summarised from Weston (1929, 1942) -

Conidiophores 300-450 μm long, comprising a basal swollen cell 8-(10)-13 μm wide extending 68-110 μm to a delimiting septum, a main axis expanding gradually, 120-(170)-200 μm x 20-(28)-34 μm , and a branch system 70-130 μm x 100-130 μm with 2-4 primary branches, then secondary, tertiary and quaternary branches each terminating in a tapering sterigma 10-15 μm long bearing a conidium; conidia obovoid, 21-(25-31)-39 μm x 13-(17-23)-31 μm , hyaline, with a thin unmodified wall and germinating by hyphae; oogonia ovoid-spherical, occasionally with bluntly rounded projections, 28-44 μm in diameter, oogonial wall closely adherent to the oospore within, wall 3-(5-10)-20 μm thick, rich golden-brown; oospores spherical 20-(23-29)-34 μm , wall hyaline, pale golden, 1-3 μm thick, germination not observed.

Downy mildew-infected tussocks of *S. leiocladum* were found at upland localities in south-eastern Queensland. Several tussocks were transplanted to a garden plot at the University of Queensland, St. Lucia, Queensland to provide a source of fresh sporulating material. The morphology of the asexual and sexual states of this downy mildew could then be compared with the descriptions of *P. noblei* (Weston, 1929, 1942) which had been based on preserved material.

Two types of mature conidiophores were found (Table 2). The first, here referred to as the normal type, comprised the vast majority of conidiophores. The second "abnormal" type was occasionally formed both in the field and in the laboratory. The characteristics of the mature "normal" conidiophores were identical in most respects to those given by Weston (1942), except that he stated that sterigmata were 10-15 μm long, whereas in this study they were found to be 10-40 μm depending on whether they were on secondary, tertiary or quaternary branches.

The asexual spores formed on the "normal" and "abnormal" conidiophores were similar in most respects to those described by Weston (1942). The walls of the conidia were thin, hyaline and smooth and did not have any apical thickening or modification. There were differences in spore dimensions between Weston (1942) and the present study. The conidia collected from transplanted tussocks were 21-(27.6 $\pm$ 2.3)-35 μm x 13-(23.2 $\pm$ 2.3)-31 μm , being the same length, but wider than those reported by Weston

(1942). The discrepancy between Weston's data and that of the present study may be due to the use of preserved material by Weston.

Table 2. Some characteristics of normal and abnormal conidiophores of *Peronosclerospora noblei*

Characterisitics	Weston (1942)	Present study	
		Normal	Abnormal
Total length (µm)	300 – 450	230 - 450	70 - 184
Basal cell (µm)	68 – 110	60-115	absent
Branches ¹	1°, 2°, 3°, 4°	1°, 2°, 3°, 4°	None, 1° or 2°
Sterigmata length (µm)	10 – 15	15 - 40	30 - 40(1°), 15-20(2°)
Spores/conidiophore	24 - 48	20 - 52	3 - 8

¹ 1°, 2°, 3°, 4° = primary, secondary, tertiary and quaternary branches

The mode of conidium germination was studied by spraying freshly harvested conidia onto 1.5% water agar in 9 cm plastic petri dishes, which were sealed and incubated in the dark at 4°C intervals between 16°C and 32°C. The spores germinated directly at all temperatures by producing one or rarely two thin-walled aseptate germ tubes 3-5 µm in diameter.

Oogonia collected from frayed leaves of *S. leiocladum* at several localities in southern Queensland and in the vicinity of the type locality in New South Wales were identical in every respect to those described for *Sclerospora noblei* by Weston (1929). The characteristics of the sexual state of this species based on these collections are – Sexual state consisting of an oospore borne singly and surrounded by a thick wall of two fused elements, a thin oogonium wall, and a thick exosporium; oogonia 28-44 µm in diameter, ovoid, elliptical or subglobose, with flattened sides bordered by inconspicuous ridges, outer surface of the oogonium generally smooth, occasionally scabrid, remnants of the oogonial stalk or of the antheridium sometimes adherent to the oogonium; oogonium wall hyaline and 1.0-1.5 µm thick [difficult to detect by light microscopy, even at high magnification (ca. x1000)]; exosporium pigmented and variable in thickness (4-6 µm); oospore globose, 19-(26.4±2.4)-35 µm in diameter with a hyaline, smooth wall (endosporium) of even thickness (3-4 µm). Germination not observed.

Specimens examined: On *Sorghum leiocladum*: Hirstglen, Queensland, 3.vii.1978, M.J. Ryley (BRIP 14533); Glencoe, New South Wales, -.vii.1978, M.J. Ryley (BRIP 14391); Upper Pilton, Queensland, 4.i.1979, M.J. Ryley (BRIP 14389); Stuart R., Queensland, 1.iv.1979, M.J. Ryley (BRIP 14387); Cooyar, Queensland, 1.v.1979, M.J. Ryley (BRIP 14390); St Lucia ex Hirstglen, Queensland, 4.iii.1979, M.J. Ryley (BRIP 14352). On *Sorghum plumosum*: Glen Innes, New South Wales, Australia, -.ii.1928, R.J. Noble (TYPE: ex Herb. W.H. Weston)(FH). (Host now called *Sorghum leiocladum*.)

Examination of frayed leaves from infected tillers in the field showed that prolonged exposure to the weather resulted in morphological changes to the sexual spores. The ridges on the oogonium became less pronounced, and the oogonium diameter gradually decreased. After 8 months the thin oogonium wall had disappeared, and the outer surface of the exosporium was smooth, lacking the scabrid appearance of newly-formed oogonia. Although the diameter of the propagules had decreased to 24-38 µm due to the weathering of the exosporium, the oospore diameter range remained unchanged.

The characteristics of the downy mildew on *Sorghum leiocladum* agree very closely with those of *S. noblei* described by Weston (1929, 1942). The asexual spores are true conidia as defined by Shaw (1978) in that they have a uniform wall, lack an apical papilla and always germinate by one or two germ tubes. There is no doubt that

this downy mildew should be called *P. noblei*. The production of 'abnormal' conidiophores with a reduced branch system has no taxonomic significance because it has been reported for other graminicolous downy mildews, *Sclerospora graminicola* (Safeulla and Thirumalachar, 1956), *Peronosclerospora sacchari* (Bonde and Melching, 1979), *P. sorghi* (Safeulla, 1976) and *P. philippinensis* (Weston) C.G. Shaw (Kimigafukuro, 1979). This study has shown that care must be taken when using oogonium diameter and exosporium ornamentation as taxonomic criteria. Prolonged weathering can affect these characteristics. On the other hand, oospore diameter is an immutable character.

Sorghum leiocladum is a strongly tussocked, densely caespitose perennial. In southern Queensland the grass is found growing on volcanic-derived soils on ranges and plateaux. Healthy tussocks consist of tightly-packed underground tiller bases from which two types of tiller develop. There are short vegetative tillers, 30-40 cm high with three to four arching narrow green leaves, which are present throughout the year. Individual tillers rarely survive for more than one year. During late spring and early summer (October to February) tall flowering tillers, up to 1.25 m high, with narrow green leaves and each bearing a loose terminal panicle develop over one short period (14 to 21 days) in response to rainfall.

Infected tussocks consist of short vegetative tillers similar to those in healthy tussocks, and tall vegetative tillers bearing wide chlorotic leaves on/in which the reproductive structures of *P. noblei* develop. Flowering tillers develop on some infected tussocks and not on others. Infected tillers have more nodes (mean = 7.8 vs 3.2), and wider culms (mean = 2.1 mm vs 1.7 mm) and leaves (mean = 6.5 mm vs 2.8 mm) than flowering tillers. The chlorotic leaves are held in an upright manner and are close together, resulting in a bunched appearance. The vast majority of infected tillers are vegetative, but malformed inflorescences develop on a few tillers.

Hyphae of *P. noblei* perennate in tiller bases, moving into some buds and not others when tillers begin to elongate. Invaded buds develop into systemically infected tillers, the hyphae in the apical growing point infecting leaves as they develop. Sporulation of *P. noblei* is confined to the abaxial leaf surfaces of chlorotic leaves of these special tillers, with the area of sporulation spreading in a series of steps from the tip towards the ligule. Differences in stomatal density between the abaxial (mean 19460 stomata/cm²) and the adaxial (4200 stomata/cm²) surfaces may be responsible for the absence of conidiophores on the adaxial surface. In any chlorotic area of the leaf blade, only two crops of conidiophores develop. During the life of an individual tiller, asexual sporulation occurs simultaneously on all chlorotic leaves, even though at a particular time they are in various stages of development. On the lowermost one or two chlorotic leaves, sporulation does not occur until they are fully expanded, but on younger leaves sporulation can occur soon after they are exposed. Occasionally conidiophores develop on the sheaths of chlorotic leaves (but then extending only 10-20 mm past the ligule), and on the spikelets of underdeveloped inflorescences on infected tillers.

Soon after a diseased tiller reaches its maximum height the last formed, partly expanded chlorotic leaves die rapidly from the tips towards the ligules. By this time some of the lowermost infected leaves are dead while others may be partly necrotic. Fraying of the leaf blades, which is associated with the expansion of the tightly packed oogonia in the interfascicular parenchyma, usually begins simultaneously at the tips of all or some of the uppermost three or four leaves. Within 7 days, all of the infected leaves which will ultimately fray have begun to disintegrate. On some infected leaves, fraying may commence while there is still some chlorotic tissue at the proximal end of

the blade, but asexual sporulation ceases when fraying starts. In the winter months when the grass is dormant, tall dead tillers bearing frayed leaves are the dominant feature of the symptom picture at many sites where *S. leiocladum* grows. The robust, thick infected tillers are more capable of withstanding weathering than are the remnants of healthy flowering tillers.

3. The downy mildew of *Sorghum plumosum*

This specimen was collected in June 1978 from Lizard Island, approximately 100 km north of Cairns. It consists of a number of frayed leaves with oogonia adhering to the necrotic remnants of the vascular bundles. The sexual state of the downy mildew has the following characteristics –

Oogonia spherical to subspherical with smooth polygonal faces, 26-44 μm in diameter, oogonium wall hyaline, 1.0-1.5 μm thick and fused to exosporium, exosporium pigmented, variable in thickness; oospore more or less central, adnate with the exosporium, 19-(26.2 $\pm$ 2.2)-30.0 μm in diameter with a thin, hyaline wall (endosporium) 1.0-2.0 μm thick. Germination not observed. Asexual state not seen.

Specimen examined: On *Sorghum plumosum*: Lizard Island, Queensland, 7.vi.1978, V. Boughton (BRIP 14388).

Four downy mildews have been recorded on *Sorghum plumosum* – *P. maydis* (Ramsey and Jones, 1988); *P. miscanthi* (Miyake) C. G. Shaw (Frederiksen and Renfro, 1977); *P. philippinensis* (Frederiksen et al., 1970) and *P. sorghi* (Bonde and Freytag, 1979). The records of the last two fungi are based on the results of inoculations and neither has been recorded on *S. plumosum* in the wild. The characteristics of the sexual state of this specimen differ from those reported for all of the last three fungi (Waterhouse, 1964). The report of *P. maydis* on *Sorghum plumosum* by Ramsey and Jones (1988) was based on studies made in the Atherton Tableland district of northern Queensland. Here a severe epidemic of *P. maydis* developed on maize (*Zea mays* L.) in 1985 and there was strong evidence that infected plants of *S. plumosum* were acting as alternative hosts. However, oospores never developed on *P. maydis*-infected plants of *Z. mays* or *S. plumosum*. In fact, the sexual state of *P. maydis* is unknown (Kenneth, 1981). In our opinion it is unlikely that the Lizard Island specimen is *P. maydis*, because of the presence of oospores.

The range of oospore diameter and the ornamentation of the oogonia are very similar to those of *P. noblei* recorded by Weston (1929, 1942) and reported in this study. However, the identity of the fungus can be determined with certainty only when a study of its asexual state is made.

4. The downy mildew of *Eragrostis* sp.

This specimen consists of the upper portion of a culm with five frayed leaves but no inflorescence. The characteristics of the sexual state found adhering to the remnants of the frayed leaves are as follows–

Oogonia spherical to subspherical, 30-44 μm in diameter, oogonium wall hyaline, 1.0-2.0 μm thick and fused to the exosporium, 3.5-7.5 μm thick, exosporium pigmented, 2.5-3.0 μm wide with rounded, hyaline papillae, 3.5-4.5 μm high, 4.5-6.0 μm wide at base; oospores one per oogonium, adnate with exosporium, centrally located, spherical, 19-(24.3 $\pm$ 2.3)-30 μm , oospore wall (endosporium) hyaline, 2-3 μm thick. Germination not observed. (Figure 2A). Asexual state not seen.

Specimen examined: On *Eragrostis* sp.: Charleville, Queensland, -v.1955, A. Johnson (BRIP 2105).

Two graminicolous downy mildews have been recorded on *Eragrostis* species, namely *Sclerophthora macrospora* (Saffeuilla, 1976) and *Basidiophora butleri* (Weston) Thirum. & Whitehead (Weston, 1933). *Sclerophthora macrospora*, which has been recorded on over 140 hosts throughout the world (Saffeuilla, 1976; Shaw, 1981), has smooth-walled spherical to subspherical oogonia, 34-70 x 36-62 μm in diameter and oospores 35-70 μm in diameter. The downy mildew of *Eragrostis* from Queensland has papillate oogonia which are much smaller than those of *S. macrospora*. *Sclerospora butleri* Weston was described on *Eragrostis aspera* (Jacq.) Nees by Weston (1933) as having spherical to subspherical oogonia, 21-(33-37)-43 μm in diameter with bluntly-rounded, papillate projections, 2-5 μm high, with a central oospore 15-(19-23)-27 in diameter. Later, Thirumalachar and Whitehead (1952) described the asexual state of that fungus on *Eragrostis plumosa* (Retz.) Link. The sporangiophores were simple, unbranched, pedicel-like cells, obconical, narrow at the base and up to 22 μm long and 12 μm wide. Six to eight lemon-shaped sporangia (28-34 μm x 15.5-22 μm) developed on short sterigmata at the apices of the sporangiophores. Thirumalachar and Whitehead (1952) proposed a new combination, *Basidiophora butleri* (Weston) Thirum. & Whitehead for this fungus based on the morphology of its asexual state.

Two other graminicolous downy mildews, namely *Peronosclerospora heteropogoni* Siradhana, Dange, Rathore & Singh and *Sclerospora iseilematis* Thiram. & Naras., possess papillate oogonia. The oospores of *P. heteropogoni* are 25-(29)-37 μm in diameter (Siradhana et al., 1980), while those of *S. iseilematis* are 38-50 μm in diameter (Thirumalachar and Narasimhan, 1949). The upper and lower limits of the oospore diameter of both downy mildews are greater than the corresponding values for the *Eragrostis* downy mildew. The mean oospore diameter and exosporium ornamentation of the *Eragrostis* downy mildew in Queensland is very similar to those reported for *Basidiophora butleri*.

There are two important characteristics of the genus *Basidiophora* which are relevant to the taxonomic standing of *B. butleri*. Firstly, the other two valid species of *Basidiophora*, that is, *B. entospora* Roze & Cornu and *B. kellermanii* (Swingle ex Sacc.) Wilson occur only on members of the Family Asteraceae (Constantinescu, 1998). Recently, Constantinescu (1998) erected a new genus, *Benua* Constant., with *B. kellermanii* the type and only species, based mainly on the characteristics of the sporangiophores. Secondly, Francis (1981) and Constantinescu (1998) stated that in the genus *Basidiophora* the sporangia fall away from the sporangiophore with a small part of the sterigma attached, but Thirumalachar and Whitehead (1952) did not report this feature for *B. butleri*.

The transfer of *S. butleri* to *Basidiophora* was based solely on the characteristics of the asexual state which are considered to be reliable criteria for generic delimitation within the Family Peronosporaceae (Hall, 1996). However, when the facts above are taken into account, the placement of *S. butleri* in *Basidiophora* is questionable. Barreto and Dick (1991) rejected *Basidiophora butleri*, suggesting that it be better placed in *Sclerospora*, and Constantinescu (1998) did not consider the species in his revision of *Basidiophora*.

The downy mildew found on *Eragrostis* sp. in Queensland is similar in many respects to the fungus now called *Basidiophora butleri*. However, until the asexual state of the Queensland specimen is found, its taxonomic status will remain in doubt.



Figure 2. A Scanning electron micrograph of papillate oospore of the downy mildew on *Eragrostis* sp. (BRIP 2105). B Photomicrograph of oospores of the downy mildew on *Triodia pungens* (BRIP 2107).

5. The downy mildew of *Triodia pungens*

Specimens of a downy mildew on *Triodia pungens* have been found at two localities in Queensland. The collection made at Yalloroi consists of four intact plants, each with a number of tillers up to 15 cm high. The uppermost leaves on each culm are frayed, with oogonia attached to the remnants of the vascular bundles, while the lower leaves are intact, and do not contain oogonia. No inflorescences were found in the upper portions of any of the culms. The Barcaldine collection consists of a few frayed leaves. The sexual states found on the two specimens did not differ. They have the following characteristics –

Oogonia subspherical, with flattened faces, 32-47 µm in diameter, oogonium wall fused to exosporium, hyaline, 1.0-1.5 µm thick, exosporium pigmented, variable in thickness; oospores one per oogonium, centrally placed, spherical, 25-(29.9±2.1)-35 µm, adnate with exosporium, oospore wall (endosporium) 2-3 µm thick. Germination not observed. (Figure 2B). Asexual state not seen.

Specimens examined: On *Triodia pungens*: Yalloroi, Queensland, 23.vi.1952, E. F. Henzell (BRIP 2106); Barcaldine, Queensland, 13.vi.1974, R.G. Silcock (BRIP 2107).

There have been no previous reports of a downy mildew on *Triodia*. The characteristics of the oogonium wall and the range of oospore diameter of this downy mildew are similar to those of *Peronosclerospora noblei* recorded in this paper and by Weston (1929). However, only a study of the asexual reproductive structures of this graminicolous downy mildew will determine its taxonomic position.

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RHIZOPOGON BUENOI (BOLETALES, BASIDIOMYCOTA) A NEW SPECIES FROM SPAIN

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Abstract

Rhizopogon buenoi is described as a new species, based upon macro-, micromorphology and DNA sequencing features. Relationships with close species are discussed.

Key words: Hypogeous fungus, morphology, molecular analysis, ITS rDNA, taxonomy.

INTRODUCTION

Going on with our research project within Flora Mycologica Iberica, and following the theme of recent publications (MARTÍN, 1996; MARTÍN & CALONGE, 2000; CALONGE & MARTÍN, 2000) we are proposing a new species of *Rhizopogon* from Spain growing under *Pinus sylvestris* L.

MATERIAL AND METHODS

MATERIALS.- The material studied was collected growing under *Pinus sylvestris* in sandy soil. Spain, Ávila, Arenas de San Pedro, Hontanares, 21-XI-1998, leg. S. Barbero, MA-Fungi 47676.

MORPHOLOGICAL CHARACTERS.-Specimens were examined to define the macroscopic and microscopic characters, following the criteria outlined by SMITH & ZELLER (1966) and MARTÍN (1996).

MOLECULAR ANALYSIS.- Total DNA was isolated, amplified and sequenced according to CALONGE & MARTÍN (2000). Sequences were obtained at the Automatic Sequencing Service (CIB-CISC, Madrid, Spain). Sequence Navigator™ Sequence Comparison software (Perkin

Elmer) was used to identify the consensus sequences from the two strands. The new sequence has been logged in the EMBL database with the Accession Number AJ297263. Sequence obtained in this study were compared with homologous sequences in the alignments mentioned in JOHANNESSON & MARTIN (1999) and *R. aromaticus* Calonge & M.P. Martín (MARTÍN & CALONGE (2000). SEQAPP software for multiple sequences was used to search for the best alignment. Parsimony analysis was performed using the computer program PAUP 4.0b* (SWOFFORD, 1996). Branch robustness was estimated by bootstrap analysis (FELSENTEIN, 1985) of 1000 heuristic replicates.

RESULTS

DESCRIPTION

Rhizopogon buenoi Calonge & M.P. Martín, sp. nov.

Etym.: Dedicated to Francisco Bueno, an excellent collaborator.

Diagnosis.- *Basidiomata subhypogaeus, angiocarpous, globosa, subglobosa, tuberoidea vel irregularia, 2.5-7 cm lata, sessilis. Peridium album. Rhizomorpha abundantis presentis in basis. Gleba crema brunnea. Columella nulla. Sporae ovoidae-ellipsoidae vel cylindricae, truncatae, biguttulatae, 5-7 x 2.5-3.5 μ m, non amyloideae. Basidia 2-4 sporigena, cylindrica, 15-22 x 5-8 μ m. Brachybasidiola pyriformis, aequalis dimensionis basidia. Peridium simplum, 100-200 μ m latum, corsicus-typus. Trama hymenophoralis homoiomera, hypha 3.5-10 μ m lata. Holotypus: Hispania, Ávila, Arenas de San Pedro, Hontanares, subter Pinus sylvestris, 21-XI-1998, legit S. Barbero. MA-Fungi 47676.*

Basidiomata aggregate, glabrous, subhypogaeal, angiocarpous, globose to tuberoid, 2.5-7 cm diam., sessile, with numerous rhizomorphs at base. Peridium glabrous, white, on bruising there is no colour change. Gleba white then cream-colour, labyrinthiform; soft and cartilaginous when fresh, bone-hard on drying; odour absent, taste light sweet which remains hazelnuts.

Chemical reactions: When contacting KOH on peridium becoming violet-lilac, then dark brown-reddish, and on gleba light yellowish.

Spores ovate-ellipsoid to cylindrical, truncate, 5-7 x 2.5-3.5 μ m, pale yellowish smooth and biguttulate, neither amyloid not with small areas of spore blackening in Melzer's reagent (Fig. 1a). Basidia 2-4-spored, cylindrical to clavate, 15-22 x 5-8 μ m mixed with basidioles. Peridium simple, < 200 μ m thickn, formed by hyphal packets arranged in two directions (*corsicus*-type; Fig. 1b). Constituent hyphae are 4-10 μ m diam., hyaline, thin-walled, septate, branched, coated with numerous orange-brown pigmented masses. Hymenophoral trama of laxly interwoven hyphae, 3.0- 10.0 μ m diam., rather gelatinized, refractive, septate, thin-walled and little branched.

Molecular characters. In the cladistic analysis, *R. buenoi* clades as a sister group of *R. aromaticus* (data not known). The 21 different base pairs between the ITS rDNA sequences of *R. buenoi* and *R. aromaticus* are shown in Fig.2.

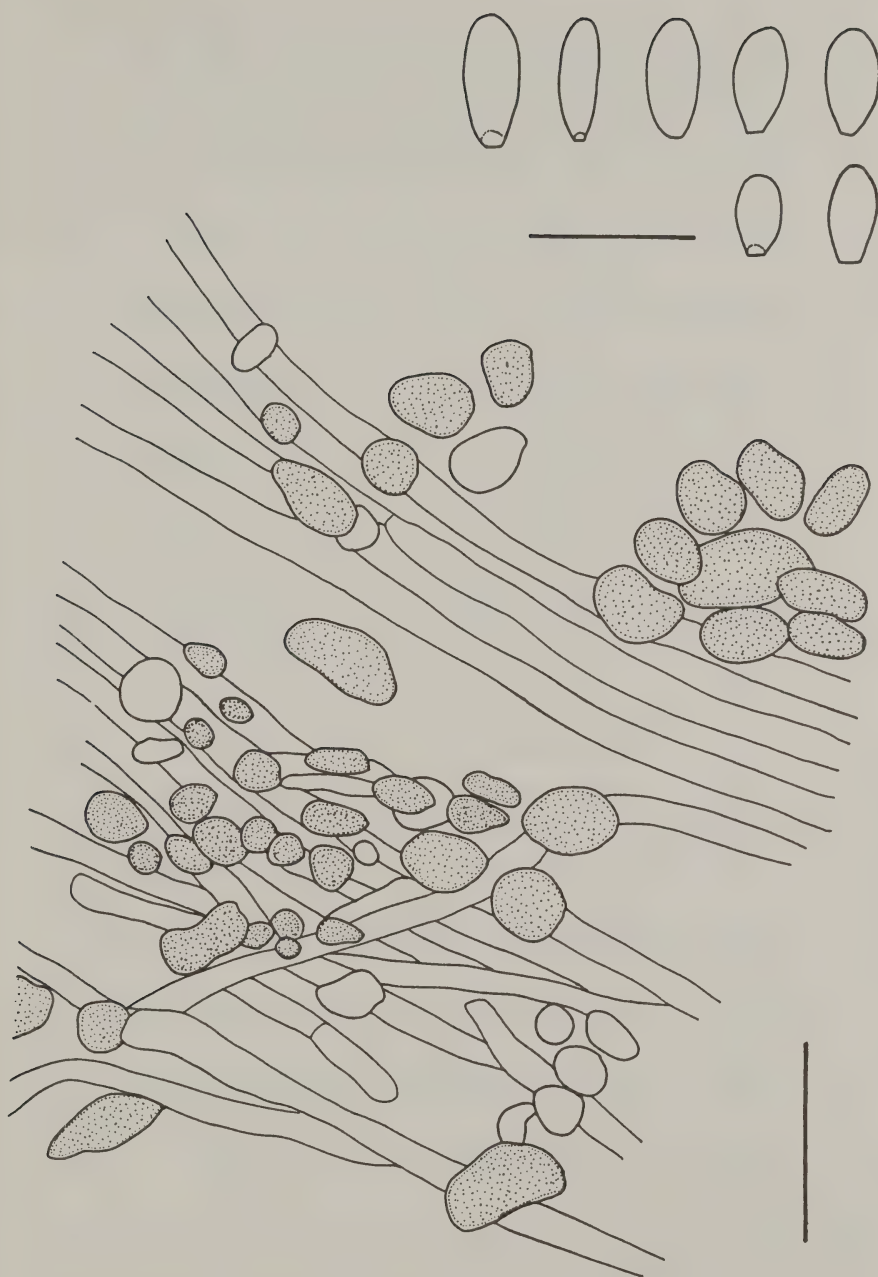


Fig. 1 *Rhizopogon buenoi*. a) Spores (bar= 10 μ m); b) Peridium corsicus-type (bar= 50 μ m).

R_ AROMAT	ATATA ATAAGCGG AGGAGCC	GTAG GT GATCCTGG CCTT G T
R_ BUENOI	NNNN TTTACCT -AGGAG--	GTAG TT GTGTGCTGG ACTT - T
R_ AROMAT	AACGAGGGCATGTGCACACT	ATGTCTTATCATTACCTCTC
R_ BUENOI	AACGAGGGCATGTGCACACT	ATGTCTTATCATTACCTCTC
R_ AROMAT	TCTCTCTCACCTGTGCACTA	ACTG CG GGTTCAGCCAGCTG
R_ BUENOI	TCTCTCTCACCTGTGCACTA	ACTG TAG GGTTCAGCCAGCTG
R_ AROMAT	ATTTTGTCTCGTATGAACCT	ATGTCCTTCATATACATCTT
R_ BUENOI	ATTTTGTCTCGTATGAACCT	ATGTCCTTCATATACATCTT
R_ AROMAT	TGTGTAGAAAGTCTTTGAAT	GTTTATTATCGGAGAGTTGC
R_ BUENOI	TGTGTAGAAAGTCTTTGAAT	GTTTATTATCGGAGAGTTGC
R_ AROMAT	GACTTCTAGGAGTAGTGAAT	CTTTGAGACAA AC GTTATTA
R_ BUENOI	GACTTCTAGGAGTTGTGAAT	CTTTGAGACAA AA GTTATTA
R_ AROMAT	CAACTTTCAGCAATGGATCT	CTTGGCTCTCGCAT CC GATG
R_ BUENOI	CAACTTTCAGCAATGGATCT	CTTGGCTCTCGCAT C -GATG
R_ AROMAT	AAGAACGCAGCGAAAAGCGA	TATGTAATGTGAATTGCAGA
R_ BUENOI	AAGAACGCAGCGAAAAGCGA	TATGTAATGTGAATTGCAGA
R_ AROMAT	TCTACANNNNNNNNNNNNN	NNNNNNNNNNNNNNNNNN
R_ BUENOI	TCTACAGTGAATCATCGAAT	CTTTGAACGCACCTTGCCT
R_ AROMAT	NNNNNNNNNNNNNNNNNN	NNNNNNNNNNNNNNNNNN
R_ BUENOI	CCTTGGTATTCCGAGGAGCA	TGCCTGTTTGAGTGTGAGTA
R_ AROMAT	NNTTCTCAACCCCT TT CAAT	TAGCTTTGA AG GGGAGCTTG
R_ BUENOI	ATTTCTCAACCCCT CT CAAT	TAGCTTTGAGGGGAGCTTG
R_ AROMAT	GATAGTGGGTGTTGCCAGAG	ACTTTACGATCCAATCGTAA
R_ BUENOI	GATAGTGGGTGTTGCCAGAG	ACTTTACGATCCAATCGTAA
R_ AROMAT	GACTTGGGCTCACCTGAAAT	GCATTGGCTTGCACTCAACC
R_ BUENOI	GACTTGGGCTCACCTGAAAT	GCATTGGCTTGCACTCAACC
R_ AROMAT	TTTGACTTTGCATGATAAGG	CTTTCGGTGTGATAATGATC
R_ BUENOI	TTTGACTTTGCATGATAAGG	CTTTCGGTGTGATAATGATC
R_ AROMAT	GCCGTGTGCTGAAGTGCATG	AATAAAGGTTCTGTGCCTCT
R_ BUENOI	ACCGTGTGCTGAAGTGCATG	AATAAAGGTTCTGTGCCTCT
R_ AROMAT	AATACAGGTTGGGTTTGGTT	GGATTGACTTTAGTCTTTCT
R_ BUENOI	AATACCGGTTGGGTTTGGTT	GGATTGACTTTAGTCTTTCT
R_ AROMAT	ACGATATTCCCCCN	NNNNNNNNNNNNNNNN
R_ BUENOI	AC-ATATTCCCCCTTTT	GACTTTTGACCTCAA

Fig.2 Comparison of the nucleotide sequences of the ITS1, 5.8S and ITS2 (complete sequence) *R. buenoi* (R_BUENOI) and *R. aromaticus* (R_ AROMAT). "-"= Alignment gaps; "N"= Unresolved or unknown nucleotides.

DISCUSSION

From characters of the peridium, *R. buenoi* could well be related with *R. corsicus* Moyersoen & Demoulin, *R. ochraceorubens* A.H. Smith and *R. subalpinus* A.H. Smith. However, in these three species the rhizomorphs cover the whole peridium surface, whereas in *R. buenoi* the rhizomorphs are attached to the basidiome base. Moreover, with KOH the peridium in *R. corsicus* and *R. subalpinus* is unchanging. The chemical reaction in *R. buenoi* is similar to *R. ochraceorubens* due to the presence of pulvinic acids (Martín & Tellería, unpublished).

There are other species with truncate and non-amyloid spores; however, they show different types of peridium (MARTÍN, 1996), e.g. *R. abietis* A.H. Smith (*abietis*-type: hyphae forming a loosely interwoven weft), *R. luteolus* Fr. & Hordholm and *R. verii* G. Pacioni (*luteolus*-type: hyphal packets arranged in different directions) and *R. vinicolor* (*roseolus*-type: hyphae running parallel to the surface). The peridium type clearly separates *R. buenoi* from the species included in Subsection *Fulviglebae* of SMITH & ZELLER (1966), which shown *abietis*-type or *roseolus*-type.

The magnitude of sequence variation in ITS rDNA between *R. buenoi* and *R. aromaticus*, together with the different morphological characters (peridium *roseolus*-type, not truncate spores and spore wall becoming dark bluish with Melzer in *R. aromaticus*), allow the separation of both taxa.

It is therefore apparent that this newly described species has a unique suite of macro- and micromorphological characters which are conclusively supported by molecular analysis.

ACKNOWLEDGMENTS

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HYMENOCHAETOID FUNGI (BASIDIOMYCOTA) OF NORTH AMERICA

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28 species of the genera *Asterodon*, *Dichochaete* and *Hymenochaete* found in northern America (Greenland, Canada, Temperate Mexico and USA), two dubious species and one not yet found here are described, their distribution and hosts (substrata) characterized. Morphological characters in use for identification are described and keys to species found in this region are given. The number of species inhabiting different zones diminishes from southeastern USA (23 species) to northern Subarctic America (4 species).

Keywords: *Asterodon*, *Dichochaete*, *Hydnochaete*, *Hymenochaete*, North America

INTRODUCTION

Hymenochaetoid fungi (families Asterodontaceae, Clavariachaetaceae and Hymenochaetaceae) is a group of the order Hymenochaetales (Hymenomycetes, Basidiomycota) characterized by resupinate (effused), effused-reflexed, pileate or clavarioid non-poroid basidiomata (fruitbodies). In one species (*H. damicornis*) the pileate basidiome is stalked. Hymenophore is smooth, in some species colliculose, with flattened teeth or in some species hydroid; basidiome is brown, sometimes yellowish or blackish; the colour darkens when moistened with KOH solution (*xanthochroic reaction*). Hyphae are with simple septa (without clamps); hyphal system is sometimes subdimitic, i. e., differentiated into subhyaline thin-walled generative hyphae and brown thick-walled skeletoids. In hymenium thick-walled brown or dark brown subulate or fusoid cystidia-like cells (*setae*) are present. Usually the setae are very numerous, hymenium is thickening and a *setal layer* will be formed. Basidia are clavate or subutriform, bear four (rarely two) sterigmata and on these hyaline, thin-walled, non-amyloid spores.

All species inhabit angiospermic or gymnospermic wood, being on dead trunks, branches and twigs; fallen logs and other wood, as an exception on bark scales of living trees, living twigs or seemingly on ground but really on buried roots or pieces of wood. All species cause white fibrose or pocket rot of wood.

GEOGRAPHICAL SCOPE

This paper covers Northern America as delimited by the Plant Taxonomic Database Standard No 2 (Hollis & Brummitt, 1992) including Greenland, Canada, Alaska south to central Mexico. The Western Antilles, southeastern Mexico and countries to the South are excluded because they belong to the Mesoamerican Plant Region of Southern America. One species common in Mesoamerica and Caribbean regions has been included because it may occur in southern regions of the area.

FORMER STUDIES IN NORTHERN AMERICA

Few species of Hymenochaetoid fungi were mentioned in Northern America before Burt's survey was published in 1918. Of the new species of *Thelephora* by Schweinitz, two were later transferred to *Hymenochaete* (*H. episphaeria* and *H. imbricatula*, a synonym of *H. tabacina*). Peck described four new taxa of *Hymenochaete* and one of *Hydnochaete*; two of these (*Hymenochaete spreata* and *H. tenuis*; Peck, 1878, 1887) are accepted here. Banker (1914) published a paper on nomenclature and synonymy of *Asterodon* and *Hydnochaete*; however, according to his views, the last named genus belongs to pore fungi (Polyporaceae s. l.). Ecology of *Hymenochaete agglutinans* (= *H. corrugata*), a facultative parasite causing death of several angiospermic trees and bushes was studied by Graves (1914); these data were supplemented by Overholts' (1924) studies. Timber rot caused by *H. rubiginosa* was studied by Brown (1915). In the monograph of the genus *Hymenochaete* by Burt (1918), 10 new species were described from N. America and Cuba. He gave descriptions of 21 species found in the region; of these, 6 are now synonyms, 2 are dubious species. In a later paper (Burt, 1924), the only species of the genus *Asterodon*, *A. ferruginosus* was described by him as a new species *Asterostroma ochrostroma* from New Hampshire. All collections studied by Burt were indicated in detail in his papers. Altogether, 16 species were found by him in our study area.

Some *Hymenochaete* species have been mentioned in the lists of fungal biota by several authors, but only few of them (e. g., Morgan, 1887; Gilbertson & Bigelow, 1998), have mentioned more than 2-3 species. Coker (1921) in his paper on North Carolina fungi gave descriptions of three species. In their paper of West Indian species of *Hymenochaete*, Reeves & Welden (1967) indicated four species as found in USA, and one, *H. sallei* (= *H. rheicolor*), as found in Mexico; three of these were new for USA (*H. anomala*, *H. opaca* and *H. rigidula*). *H. agglutinans* was synonymized with *H. corrugata* by them. In his unpublished dissertation, DeFigio (1970) described and listed localities of six species, found in Canada and USA; he neotypified three species described originally in Europe, using for this North American (!) specimens (*Hymenochaete fuliginosa*, *H. rubiginosa*, *H. tabacina*). This unfortunate selection was supported by Job (1990) who published the neotypification data on *H. rubiginosa* and *H. tabacina*. Two species found in northern America were described in detail in the monograph of the genus *Hydnochaete* by Ryvarden (1982). In a paper on wood-rotting fungi of the Appalachian coniferous forests, Jung (1987) described and illustrated by figures five species; three common species were described by Chamuris (1988) from Northeast USA and adjacent Canada. Two

species found in transitional area between boreal woodland and forest tundra in northern Quebec, Canada, were mentioned by Niemelä (1985). In a paper on *Hymenochaete* species of the temperate zone of the Southern Hemisphere by Job (1990), some specimens of 8 species collected in Northern America were cited, including *H. cacao* and *H. rheicolor* found in Mexico; *H. tenuis* was lectotypified by him. In his world monograph of *Hymenochaete* by Léger (1998), specimens of 13 species found in North America were used; this is also the only modern book with full descriptions (in French) of species found in the present study area.

A list of species of *Hydnochaete* and *Hymenochaete* found in the United States was published by Farr *et al.* (1989); of 19 species mentioned by them, 13 are accepted in this paper. The published data on Canadian and USA species were summarized by Ginns (1986) and Ginns & Lefebvre (1993).

Most of the data published on hymenochaetoid fungi are from USA and Canada. 17 species have been found in Mexico, but only few localities are mentioned in these papers (Burt, 1918; Reeves & Welden, 1967; Guzmán, 1972; Welden & Guzman, 1978; Escobar, 1978; Welden, Dávalos & Guzman, 1979; Marmolejo, Castillo & Guzmán, 1981; Job, 1990). Data on two species found in southern Greenland have been published by Knudsen, Hallenberg & Mukhin (1993).

Altogether 27 taxa have been noticed in literature in Northern America; of these, six (*H. agglutinans*, *H. arida*, *H. badioferruginea*, *H. borealis*, *H. spreata*, *H. ungulata*) are considered to be synonyms here, two (*H. episphaeria* and *H. opaca*) are doubtful species. Four new species have been described by Parmasto and Greslebin (Parmasto, 2001). 28 'good' species are accepted in the Northern American mycoflora.

MATERIALS AND METHODS

This paper is based on a study of herbarium specimens in the herbaria ARIZ, BPI, CFMR, LA, NY, TENN. In addition, types and some other specimens were borrowed from FH, NYS, PDD, TRTC, XAL, or studied in the European herbaria visited by me (GB, H, K, LE, O, S, TUR, UPS); the author used also his own collections from Great Smoky Mountains (1988) and Louisiana (1994). Descriptions are mainly based on the specimens from Northern America. Colours are named using Rayner's Mycological Colour Chart (1970), these names are with a capital letter. Colour notations are given using the Munsell Book of Color (1942) and Methuen Book of Colour by Kornerup & Wanscher (1967); colour names used in that book are in parentheses. Microscopic study was carried on making free-hand sections of basidiomata or as squash mounts in 2% aqueous solution of KOH. Measurements have been made using eyepiece micrometer at magnifications x 700 and x 1000, since 1998 with the aid of a Sony CCD Video Camera attached to a Nikon Labophot 2 microscope and analysed by Global Lab Image (Data Translation Inc.) software. For statistics, 25 or 30 spores were measured in each specimen. Keys to species and descriptions are compiled with the aid of the program DELTA (Dallwitz, 1980; Dallwitz, Paine & Zurcher, 1993). Herbarium acronyms are after Holmgren,

Holmgren & Barnett (1990). Latin names of substrata are unified using the Kartesz (1994) checklist.

PRESENTATION OF THE DATA

Of synonyms, only those used in North America are given. In the nomenclatural part, also the basionym of the correct name, descriptions of species by American authors or in some instances important papers (Jahn, 1971; Léger, 1998; Ryvarden, 1982, 1985) are cited. In the lists of substrata and States where a species has been found, the number of collections studied by the author of this paper is indicated in parentheses. When the author has not seen the specimens, these data are given mainly following Ginns & Lefebvre (1993) check list; no attempts were made to check once again all the literature used by them. Distribution in other regions has been indicated using Hollis & Brummitt's World Geographical Scheme for Recording Plant Distributions (1992); for these data, reliable literature sources as well as author's unpublished data have been used.

There are numerous misidentified specimens in all herbaria; to help avoiding similar mistakes, in a special paragraph the most common misnamings are indicated.

MORPHOLOGY

The basidiomata (basidiocarps, fruit bodies) are in most species resupinate (effused), i. e., without any pilei or reflexed margins. In other species, they are pileate or resupinate with elevated upper margin (effused-reflexed; part of such basidioma is resupinate, another part pileate). The form sometimes depends on the substrate: in all species, the spore-bearing hymenophore (hymenium) is directed downwards, to enable free falling of ripened spores. However, on figures presented in several papers on *Hymenochaete*, the layers of a basidiome have been shown "upside down", i. e., basidium, setae etc. pointing upwards. In one species (*Hymenochaete damicornis*), the basidiome is a vertical, sometimes scantily branched in upper part, stipe and pilei on top of it.



Fig. 1. Structure of basidiomata: T - tomentum, C - cortex, L - hyphal layer, S - setal layer, H - hymenium. (Adopted from Jahn, 1971 and Léger, 1998.)

Hymenium is smooth in most of the species; in some species it is colliculose or with low, almost subspherical warts. In the species of the genera *Asterodon* and *Dichochaete* the warts are developing to spines. In the species of the genus *Hydnochaete*, hymenophore is hydroid to odontoid.

The colour of basidiomata is always of some shade of brown, and this colour darkens or turns almost black when KOH water solution or any other alkaline reagent is used (xanthochroic reaction). The colour is not caused by some specific pigment, but mainly by polymerized polyphenols of unstable composition (Parmasto & Parmasto, 1979), or (also?) by styrylpyrones (Fiasson, 1982). The colour of a basidiome is in most species quite variable and depends on the stage of development of its hymenium. When this is without basidia and spores (sterile), it is usually much darker; when basidia and spores are present, it may be much lighter. The same bleaching takes place in old basidiomata of some species, when hymenium is covered with numerous crystals, but also when hyaline hyphal ends are forming a new layer of the thickening hymenium.

In the structure of a basidiome, several strata or layers may be distinguished under a looking glass at magnification of not less than $\times 10$; for better understanding, it must be studied under a microscope at magnification 100-400 $\times$ (Fig. 1). Depending on species, but also on age of the specimen studied, not all layers are present (except hymenium which is always present in fertile specimens).

Hymenium is the undermost layer; it consists of basidioles, basidia, setae, sometimes also of hyphidia (see below), rarely of simple cystidia. Next is the setal layer: a uniform or indistinctly stratoose layer made by thickening hymenium. Setae interwoven with more or less vertically situated hyphae is the main element of this layer; sometimes old hyphidia, in many species crystals, brown(ish) resinous matter or conglomerates of both are abundant in this layer.

Next is the hyphal layer composed of loosely or densely, more or less parallel (radiately situated) or irregularly intertwined hyphae. Different types of hyphae (thick-walled and brown, thin-walled and subhyaline) may be distinguished in different species; seta-like dark hyphae (setal hyphae) are characteristic for some species. In four species, hyphal layer seems to be divided into upper and lower part by a dark line (duplex basidiome); actually, the line is cortex and upper layer of hyphae is homologous with the tomentum.

Cortex (crust) is composed of densely agglutinated thick-walled dark hyphae; it is usually 25-250 μm thick.

Tomentum is a layer of loosely interwoven or descending fascicles of hyphae; in pileate specimens it is forming the velutinous, hairy or strigose upper surface of a pileus. In resupinate specimens, presence of a tomentum is a sign that the species is able to develop pilei (or reflexed margins), or that the species has been evolved from a pileate ancestor.

Due to the different structure of basidiomata, their consistency varies from soft or coriaceous to woody hard. Thick setal layer is making a basidiome hard and woody; when cortex is present, the basidiome is coriaceous but usually breakable, not flexible. Thin basidiomata without a cortex are bendable when

with pilei. When resupinate specimens have a tomentum (sometimes degraded to a thin layer), the basidiomata are detachable from the substrate.

Hyphae. Two main types of hyphae, generative and skeletal have been distinguished in many aphyllorphoid fungi. When both types are present, the hyphal system is called dimitic; when only generative hyphae are present, the system is called monomitic.

Generative hyphae are with septa and branching, subhyaline and thin-walled when young. Later the walls thicken and change to yellow or brown. Skeletal hyphae are typically thick-walled, brown, straight, with only rare septa and not branching. In the order Hymenochaetales, in some species the hyphal system is distinctly monomitic; in other species, it may be called subdimitic. The skeletal hyphae are not true skeletals in this case, but with rare septa, occasional branching, and there are intermediates between these *skeletoids* and generative hyphae. In other words: the hyphae are differentiated but not enough to call their system dimitic; the term *subdimitic* is used in such case.

In some species (e. g., *Hymenochaete tabacina*) there are a few setal hyphae embedded in the hyphal layer. These are very thick-walled, with greater diameter and darker walls than generative or skeletal hyphae, lacking septa, their ends are sometimes pointed as in hymenial setae.

In *Asterodon*, most of the hyphal layer is made of asterosetae - stellate or slightly branched compound setae with several simple or repeatedly branched rays (Fig. 3, 2 a).

In *Dichochaete resupinata*, many hyphae are dichotomously branched; this is a type unusual in most hymenochaetoid fungi, but observed in a tropical genus *Clavariachaete* characterized by positively geotropic branched, *Pterula*- or *Ramaria*-like basidiomata.

Hymenial setae (Figs. 2-4) are thick-walled, usually subulate, narrowly fusoid or narrowly conical; their length is about 30-120 μm , diameter 4-15 μm ; usually they emerge 10-60 μm above the hymenium. In thickening hymenium the old setae are embedded into the setal layer. In several species, setae are encrusted in upper half or at tip. This incrustation may be disolvable in KOH solution stronger than 2%, and spiral-like structure of setal walls may be seen in many species when a 10% solution is used. In most species, old setae are covered with a very thin sheath of hyaline thin-walled hyphae 0.5-1.5 μm in diam. Using scanning electron microscopy, Gilbertson & Lindsey (1978) observed another type of setal sheath in *Hymenochaete arida* (= *H. cinnamomea*), made of primary wall of young setae separated from the secondary wall during the growth of setae. No other studies on ultrastructure of setae have been published since 1978.

Cystidia have been observed in three species (*Asterodon ferruginosus*, *Hymenochaete anomala* and *H. fulva*); these are atypical, usually hardly noticeable, and may be incrustated by crystals. They are somewhat enlarged hyphal ends in the hymenium and subhymenium.

Hyphidia are similar to hyphal ends; they may be on the same level as basidioles and basidia, or may project somewhat from the hymenium. In several species, hyphidia have yellowish, brownish or brown thickened walls; sometimes they may be covered with small granules of resinous matter, and then



Fig. 2. Setae of hymenochaetoid fungi: 1 - *Hymenochaete cacao*, 2 - *H. anomala* (c - cystidia), 3 - *Hydnochaete tabacina*, 4 - *H. olivacea*, 5 - *Hymenochaete luteobadia*, 6 - *H. epichlora*, 7 - *H. tenuis*, 8 - *H. rigidula*, 9 - *H. pinnatifida* (d - dendrohyphidia), 10 - *H. unicolor*, 11 - *H. corrugata*, 12 - *H. leonina*.



Fig. 3. Setae of hymenochaetoid fungi: 1 - *Dichochaete setosa*, 2 - *Asterodon ferruginosus* (a - asteroseta), 3 - *Hymenochaete rubiginosa*, 4 - *H. escobarii* (d - dendrohyphidia), 5 - *H. carpatica*, 6 - *H. burdsallii*, 7 - *H. curtisii* (h - hyphidia), 8 - *H. cervina*, 9 - *H. jobii*.



Fig. 4. Setae of hymenochaetoid fungi: 1 - *Hymenochaete fulva* (c - cystidia), 2 - *H. americana*, 3 - *H. tabacina*, 4 - *H. fuliginosa*, 5 - *H. cinnamomea*, 6 - *H. rhabarbarina*, 7 - *H. rheicolor*, 8 - *H. damicornis*.

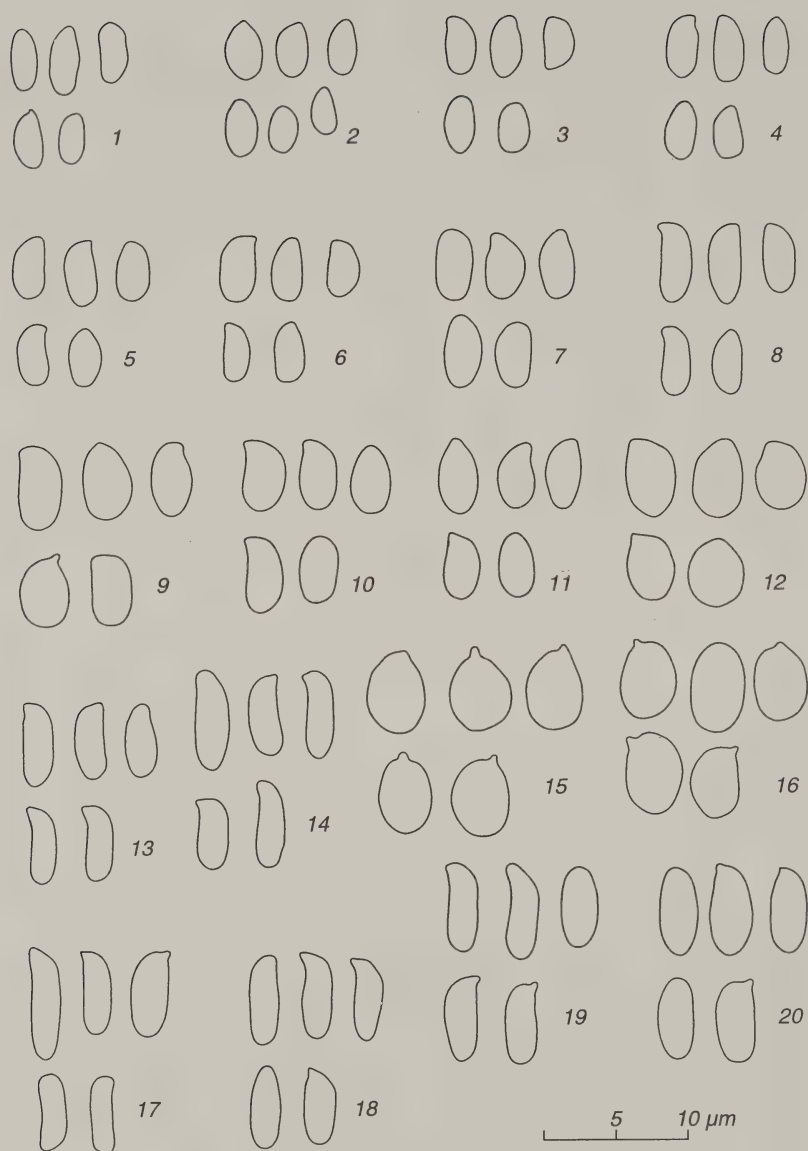


Fig. 5. Spores of hymenochaetoid fungi: 1 - *Hymenochaete rheicolor*, 2 - *H. cacao* (Léger, 1998, f. 18), 3 - *Dichochaete setosa*, 4 - *Hymenoch. epichlora*, 5 - *H. anomala*, 6 - *H. rigidula*, 7 - *H. rubiginosa*, 8 - *H. tenuis*, 9 - *H. rhabarbarina*, 10 - *H. jobii*, 11 - *H. leonina*, 12 - *H. fulva*, 13 - *H. tabacina*, 14 - *Hydnochaete tabacina*, 15 - *Hymenochaete cervina*, 16 - *H. burdsallii*, 17 - *Hydnochaete olivacea*, 18 - *Hymenochaete americana*, 19 - *H. pinnatifida*, 20 - *H. cinnamomea*.

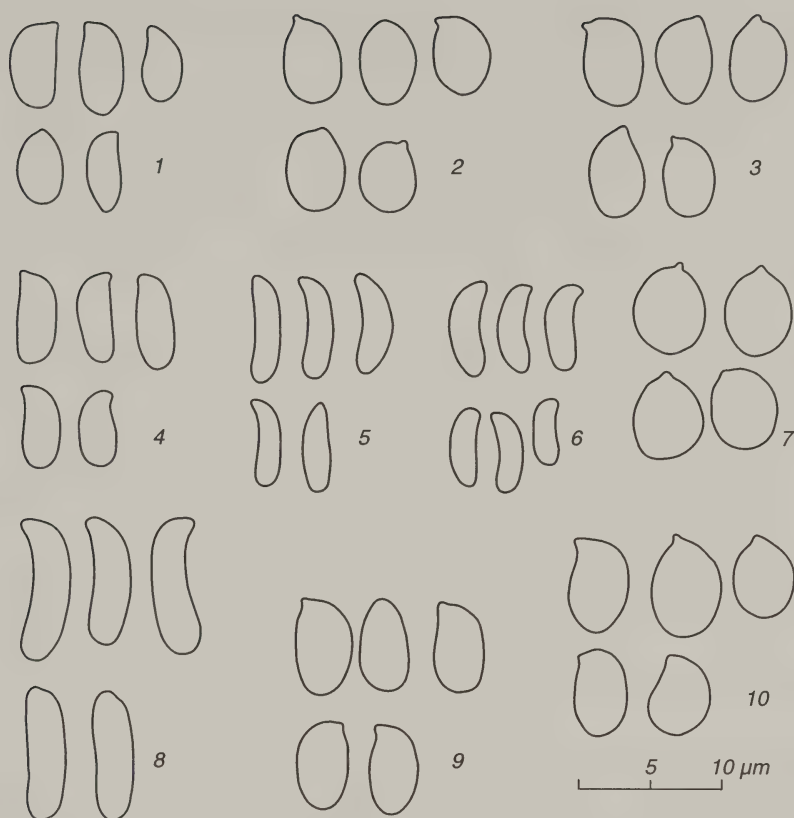


Fig. 6. Spores of hymenochaetoid fungi: 1 - *Hymenochaete luteobadia*, 2 - *Asterodon ferruginosus*, 3 - *Hymenochaete unicolor*, 4 - *H. fuliginosa*, 5 - *H. alantospora*, 6 - *H. corrugata*, 7 - *H. damicornis*, 8 - *H. curtisii*, 9 - *H. carpatica*, 10 - *H. escobarii*.

these seem to be with unevenly thickened walls or monilioid. In some species (*Hymenochaete cinnamomea* ssp. *spretta*, *H. rhabarbarina*) the encrusted hyphidia look sometimes like acanthohyphidia. Hyphidia are usually numerous in sterile hymenium before (or after) formation of basidioles and basidia.

When sterile hymenium is beginning to thicken, i.e., before formation of a new layer of setae, basidioles and basidia, growing hyphae are emerging from it. Sometimes these hyphae simulate hyphidia, and have been described as such.

Basidioles are common in most species; partly these are unripe basidia - not all basidia are sporulating simultaneously. A portion of the basidioles will remain sterile; both types may have thickened at the base, sometimes encrusted with granules of resinous matter yellow(ish) walls. Several authors (e. g., Cunningham, 1963) have called these hyphidia, and sometimes there are intermedi-

ates between basidioles and true hyphidia: both may be homologous in several species. The main difference is in size: basidioles have nearly the same measurements as basidia, hyphidia are usually of smaller diameter, and with thickened walls.

Basidia are usually thin-walled, hyaline, and either clavate or with a constriction in the upper part below the sterigmata; in last case these may be called *subutriform*. In several species, the basidial wall is thickening and yellowish at base, sometimes encrusted with brownish granules of resinous matter. When using low magnification of microscope, such basidial wall may seem unevenly thickened. In the species found in Northern America, the basidia bear four thin and short sterigmata.

Form of the *spores* (Figs. 5-6) is from subglobose or broadly ellipsoid to long cylindrical; one side of the spores is usually flattened or slightly concave; cylindrical spores may be distinctly curved. Spore size varies in limits $3-11 \times 1.2-5.5 \mu\text{m}$. The size is variable in one specimen; as an average, their coefficient of variation is $CV = 5-10$. This variation is independent of the variation of (mean) spore size in different specimens of a species; consequently, their variability in one collection does not give any information on the intraspecific variability.

Mean spore size in a specimen and mean spore length/width quotient Q is a characteristic much more informative than observed variation range. Nevertheless, in several cases comparison of these statistics in two or a few different specimens does not give us convincing information, whether they are conspecific or belong to different species. For taxonomic conclusions, but also for identification of specimens data on mean size of several specimens is necessary.

TAXONOMY

Asterodon, *Dichochaete*, *Hydnochaete* and *Hymenochaete* belong to the order Hymenochaetales - together with several genera characterized by poroid ("polyporoid") hymenophore (*Coltricia*, *Inonotus*, *Onnia*, *Phellinus*, *Phylloporia* and several segregated from these genera) or upright ramified (clavarioid, ramarioid) basidiomata (*Clavariachaete*). Presence of hymenial setae, lack of clamps on hyphae, xanthochroic brown basidiomata and smooth, colliculose or hydroid hymenophore makes it possible to distinguish the group of *hymenochaetoid fungi* easily.

History of the taxonomy of *Hymenochaete*, of its infrageneric classification and related genera was briefly given by Parmasto (1995). The genus was described by Lévêillé (1846) as a "most natural group" of theleporoid fungi. Patouillard (1900) asserted close relationship of genera with more or less smooth hymenium (*Hymenochaete*) and poroid hymenophore (*Inonotus*, *Phellinus*), and included these into *les Fomes, sér. des Igniaires*. These fungi were united into a subfamily Hymenochaetoideae by Donk (1931), was later raised to the rank of family (Donk, 1948) and by Oberwinkler (1977) to the order Hymenochaetales. The change from a subfamily to a family and then to an order was not caused by some new important findings in their morphology; it was the reflection of general devaluation of scope in taxonomic units and trend to extreme splitting of taxa.

The order Hymenochaetales seems to be a monophyletic taxon. Subdivision of it depends on views of a taxonomist; for a "lumper", no families except Hymenochaetaceae can be distinguished. Modern trends in fungal taxonomy gave preference to splitting; e. g., the families Clavariachaetaceae, Coltriciaceae, Hymenochaetaceae and Phellinaceae have been distinguished by Jülich (1982). Fiasson & Niemelä (1984) added Inonotaceae for several genera, included by Jülich (1982) into Coltriciaceae; the same scheme was followed by Knudsen (1995). However, the line between *Hymenochaete* and poroid (polyporoid) *Phellinus* is not as clear as thought earlier. The author of this paper published a new species, *H. reticulata* recently (Parmasto, 2001); according to macromorphological characters (reticulate hymenophore), it may be included to *Phellinus*.

Until molecular characters and based on these phylogenetic analysis will be employed for a new classification of Hymenochaetales, we have to avoid insufficiently founded changes in classification. A cladistic study based on morphological characters (Parmasto, 1995) has shown, that *Stipitochaete*, a satellite genus of *Hymenochaete* is indistinguishable from the latter. The other satellite, *Hydnochaete* is a paraphyletic genus with unclear position. Infrageneric taxa (sections) distinguished in *Hymenochaete* by Léger (1990) and Job (1990) based on structure of basidiomata (presence or absence of cortex, context and setal layer) are not monophyletic taxa but *grades*, useful for preliminary arrangement of species (see Parmasto, 1995). The number of species growing in Northern America is low, and that is why I did not use these arbitrary taxa in this paper.

The genera of hymenochaetoid fungi (polyporoid genera excluded) may be arranged as given below.

Asterodontaceae Parmasto: context of basidiomata composed mainly of stellate asteroetae. Spores smooth. One genus: *Asterodon* Pat.

Clavariachaetaceae Jülich: basidiomata branched, erect, or secondarily effused but with erect branched outgrowths; numerous dichotomously or crest-like branched dichohyphae present. Two genera: tropical *Clavariachaete* Corner characterized by erect clavarioid basidiomata, and mainly subtropical *Dichochaete* Parmasto with pileate or effused basidiomata (one species found in Mexico).

Hymenochaetaceae Donk: basidiomata effused or pileate; asteroetae and dichohyphae absent. Two genera easily distinguishable in Northern America (but not when all species considered): *Hymenochaete* Lév. - basidiomata with smooth or colliculose hymenium; *Hydnochaete* Bres. - basidiomata with hydroid or odontoid hymenophore.

ECOLOGY

Most species grow on dead wood or bark of fallen tree trunks, branches and twigs in forests, bushland, rarely also in open habitats. In humid climate, a few species may grow on dead hanging twigs. One species, *Hymenochaete damicornis* is growing on roots of trees, or in wood pieces buried in soil. Another, *H. carpatica* has been only found on dead bark scales of old living trees; it is a saprobiont, not a parasite. One species, *H. corrugata* may infect branches of

growing trees and shrubs; parasitic way of living is possible but not proved in other species.

All species cause a white rot, i. e., are decomposers of lignin. Some species cause a pocket rot of wood, i. e., the rotten wood has numerous small holes.

Basidiomata may develop during all vegetation seasons but in countries with temperate climate mostly late summer or early spring. Most species have perennial basidiomata: their hymenium is thickening, forming a setal layer. In some species the new annual setal layer is clearly distinguishable from the old ones, sometimes strata are separated from each other by a thin layer of interwoven hyphae. If one setal layer (and hymenium) is developing during a year, the age of basidiomata may be counted; it is usually not more than 2-3 years, but in some species up to 12 (*Hymenochaete cinnamomea*), 15 (*H. escobarii*) or 20 (*H. cervina*) years.

Most collections in all herbaria are sterile, i. e., without basidia and spores. In many cases, it is so due to slow drying of specimens: the basidia will collapse during this, and thin-walled spores will be destroyed by insects and (mainly) bacteria. Sporulation period of most species is unknown and it may be quite short. In other groups of Aphyllophorales fungi, it is usually early spring and late summer to late autumn (in Boreal Zone), when it is rainy and air temperature not high. Many species of aphyllophoroids studied sporulate late evening and early morning, or during the night, i. e., when basidiomata are usually not collected by mycologists.

DISTRIBUTION

Of the about 115 accepted species of the genera *Asterodon*, *Clavariachaete*, *Dichochaete*, *Hydnochaete* and *Hymenochaete*, more than a half have been only found in tropical or subtropical areas. 34 species have been found in the Boreal and Nemoral zones of the Northern Hemisphere, of these 11 only in this area. There are numerous species (22) which seem to have distribution of Gondwana type; 12 species have been found until only in Australasia, 17 only in Africa and 20 only in Southern America. These numbers reflect the fact that some areas are better studied than others; nevertheless, general features of their distribution show that the species are mainly of tropical/subtropical origin. The number of species specialized to grow only or mainly on coniferous wood is 4, on angiospermic wood (including 2 species only found on bamboos) - 39. For many species the preferred host is unknown.

In Northern America, the number of species diminishes from south and northeast to northwest. Of the 30 species (including two doubtful ones), 23 have been found in southeastern USA, 15 in northeastern, 15 in southwestern (mainly in Arizona), 11 in south-central, 9 in north-central USA, northwestern USA, western and eastern Canada, and only 4 in Subarctic America (two in Greenland and one in the Northwest Territories of Canada). 18 species (including 2 doubtful ones) have been found in Mexico, but this small number is obviously due to insufficient study of this area.

COLLECTING

Species of Hymenochaetoid fungi are mainly growing on fallen trunks and twigs. As other aphyllorphoroid fungi, most resupinate species prefer the underside of fallen logs or twigs. Pileate species can also grow on vertical substrate. Three species have special localities: the basidiomata of *Hymenochaete damicornis* are upright and growing seemingly on soil, actually on buried wood or roots; *H. carpatica* forms basidiomata on bark scales of living trees; *Asterodon ferruginosus* may grow not only on very rotten logs, but also under the roots of rotten stumps.

The collected specimens must be dried as soon as possible; to avoid change of colour and consistency, it is best to be done in moving air and with temperature not above 35 centigrade. Slowly dried or kept in moisture specimens are usually without basidia and spores; especially important is quick drying in tropics and subtropics, where basidia and spores will be damaged very soon.

To acquire spores for further study, it is recommended to make a spore print. When basidiomata are dry, soak these for 20-30 min in water and let them slightly dry after this. Place a moist basidiome on waterproof black paper and cover with a plastic bag to avoid rapid drying. A clearly visible white spore print will be formed in a few hours; lower temperature stimulates sporulation more than warm one. The spore print must be dried immediately and put into a small envelope. Using sterile microscope slides instead of paper, the spore print is suitable for introducing the fungus into pure culture; dry spores are viable for several weeks. Fresh spore prints as well as these kept in a herbarium many years are usable for spore measurement and statistical treatment of the results.

LABORATORY STUDY OF SPECIMENS

Colour of specimens is variable not only between species, but even more in the same basidioma during its life cycle. To describe the colour, several colour charts are available. The colours have no names in the *Munsell Book of Color* (1942 or any later variety of this, including the *Soil Color Chart*), but are denoted using a combination of letters and numbers. (E. g., deep red is denoted as 2.5 R 4/12). This costly book has been used by few mycologists in North America. Available for a much smaller cost is the book by Kornerup and Wanscher (1967). On 30 tables, 1266 colours are represented, and in addition to the colour notations (e. g., 6 C 5), vernacular names are given, too. These names are used in this paper (in parentheses) to describe the basidiomata.

MICROSCOPIC STUDY. Hand-made sections made radially from basidiomata are needed to see the structure (presence or absence of its different layers, basidia and other hymenial elements); scratch preparates may be done to measure the setae and spores. Preparates are usually mounted into 2-3 percent water solution of KOH. Avoid use of more concentrated KOH because the incrustation of setae and crystals present in basidiome may dissolve. Use of Melzer's reagent is in most cases useless, as is the use of different stains.

Spore measurements are useful for sure identification in many species. Measurement of some 7-10 spores avoiding extreme sizes may give a preliminary picture of spore size for identification. For more detailed study, 25-30 randomly taken (not selected!) spores must be measured. Arithmetic mean of

the measurements is a statistics usable to characterize a specimen (but not species!) and to study variation within a species when data on several specimens are available. In most species, spores are small and moving due to the Brownian movement; use of a microscope with image analysis equipment gives much more exact data than a usual microscope.

ABBREVIATIONS USED

G & L - Ginns & Lefebvre, 1993
K & W - Kornerup & Wanscher, 1967
M - Munsell, 1942

Abbreviations of state names

Canada

AB - Alberta
BC - British Columbia
MB - Manitoba
NB - New Brunswick
NF - Newfoundland
NS - Nova Scotia
NT - Northwest Territories
ON - Ontario
PE - Prince Edward Island
PQ - Quebec
YT - Yukon Territory

Mexico

BS - Baja California Sur
DU - Durang
JA - Jalisco
M-MI - Michoacan
M-MO - Morelos
NL - Nuevo León
OA - Oaxaca
PU - Puebla
SI - Sinaloa
SL - San Luis Potosí
TA - Tamaulipas
VC - Veracruz

United States

AK - Alaska
AL - Alabama
AR - Arkansas
AZ - Arizona
CA - California

CO - Colorado
CT - Connecticut
DC - District of Columbia
DE - Delaware
FL - Florida
GA - Georgia
IA - Iowa
ID - Idaho
IL - Illinois
IN - Indiana
KS - Kansas
KY - Kentucky
LA - Louisiana
MA - Massachusetts
MD - Maryland
ME - Maine
MI - Michigan
MN - Minnesota
MO - Missouri
MS - Mississippi
MT - Montana
NC - North Carolina
ND - North Dakota
NE - Nebraska
NH - New Hampshire
NJ - New Jersey
NM - New Mexico
NV - Nevada
NY - New York
OH - Ohio
OK - Oklahoma
OR - Oregon
PA - Pennsylvania
RI - Rhode Island
SC - South Carolina
TN - Tennessee
TX - Texas
UT - Utah
VA - Virginia

VT - Vermont
 WA - Washington
 WI - Wisconsin

WV - West Virginia
 WY - Wyoming

KEYS TO THE NORTH AMERICAN SPECIES

1. Synoptical key to some species with distinctive characters.
2. Key to species found in Greenland, Canada and northern USA.
3. Key to all species.

1. SYNOPTICAL KEY TO SOME SPECIES WITH DISTINCTIVE CHARACTERS

Pileus **stipitate**: 15. *Hymenochaete damicornis*.

Basidiomata **stratose** with **distinct** setal layers; hyphal layer(s) present: 12. *Hymenochaete cinnamomea* ssp. *spreti*, 17. *H. escobarii*, 23. *H. pinnatifida*.

Basidiomata **on bark scales of living trees**: 10. *Hymenochaete carpatica*.

In context and hymenium numerous **asterosetae**: 1. *Asterodon ferruginosus*.

In context numerous **dichohyphae**: 2. *Dichochaete setosa*.

Setal hyphae present: 1. *Asterodon ferruginosus*, 2. *Dichochaete setosa*,
 3. *Hydnochaete olivacea*, 4. *H. tabacina*, 10. *Hymenochaete carpatica*,
 26. *H. rigidula*, 28. *H. tabacina*.

Hyphidia with **hook-like curved tips**: 14. *Hymenochaete curtisii*.

Brown(ish) or yellow **hyphidia with thickened walls** present: 11. *Hymenochaete cervina*, 21. *H. leonina*, 22. *H. luteobadia*, 23. *H. pinnatifida*.

Dendrohyphidia present: 2. *Dichochaete setosa*, 17. *Hymenochaete escobarii*,
 23. *H. pinnatifida*.

2. KEY TO SPECIES FOUND IN GREENLAND, CANADA AND NORTHERN USA (north of California, Arizona, New Mexico, Texas, Arkansas, Kentucky and North Carolina)

1. Hymenophore distinctly warted or with teeth up to 2.5(-4) mm long (hydroid) 2
- Hymenium smooth or with scattered low tubercles 3
- 2 (1). Basidiomata very soft when dry, easily detachable from substrate; in context and hymenium stellate asterosetae; mycelial strands at margin usually present **1. Asterodon ferruginosum**
- Basidiomata coriaceous, woody when dry, closely adnate; asterosetae and mycelial strands absent **3. Hydnochaete olivacea**
- 3 (2). Basidiomata pileate, effused-reflexed or with elevated margins 4
- Basidiomata effused 6
- 4 (3). Setae few, in sterile hymenium numerous hyphidia with hook-like or coiled tips; spores 5.5-8.3 μ m long **14. Hymenochaete curtisii**
- Setae numerous; hyphidia absent or without coiled tip; spores 3.8-7 μ m long 5

- 5 (4). Basidiome woody hard; pileal surface velutinous, soon glabrous; hymenium not cracked or deeply scantily creviced when old; no setal hyphae
27. Hymenochaete rubiginosa
- Basidiome soft coriaceous, brittle when dry; pileal surface radially fibrose, hairy, glabrous when very old; hymenium radially or plumosely densely cracked; setal hyphae usually present but scattered, 120-250 μm long
28. Hymenochaete tabacina
- 6 (3). Dendrohyphidia absent 7
- Dendrohyphidia with thickened brownish walls, usually repeatedly branched; basidiome sometimes stratose with alternating hyphal and setal layers
23. Hymenochaete pinnatifida
- 7 (6). On bark scales of living angiospermic trees; spores ellipsoid to broadly ellipsoid, 5.5-6.5 x 3-3.5 μm
10. Hymenochaete carpatica
- Never on living trees 8
- 8 (7). Hyphal layer present (sometimes thin) 9
- Hyphal layer absent, only (thickening) setal layer present 10
- 9 (8). Basidiomata stratose, with 2-10 distinct rows of setae and sometimes a thin hyphal layer between these, thickening (up to 1-2 mm), deeply cracked; spores 4.5-6.5 x 1.8-2.8 μm
12. Hymenochaete cinnamomea ssp. spreata
- Basidiomata not stratose, thin (up to 200 μm), not cracked; spores broadly ellipsoid, 7-8 x 4.2-5.2 μm
8. Hymenochaete burdsallii
- 10 (8). Most setae with almost blunt tip, 7-15 μm in diam, in upper part always encrusted with amorphous granules or rugose; no hyphidia; spores cylindrical, slightly curved, 4.5-6.8 x 1.5-2.3 μm
13. Hymenochaete corrugata
- Setae usually with an acute tip, not encrusted or in old basidiomata sometimes encrusted in the upper part; hyphidia absent or when present, then hyaline or brownish; spores 1.8-4.3 μm broad 11
- 11 (10). Setae small, 30-60 x (5)-6-10(-12) μm , without incrustation, some with slightly curved tips, some sinuate; spores 4.5-5.5 x 2-2.5 μm
29. Hymenochaete tenuis
- Setae 55-110 x 7-15 μm , in old specimens sometimes encrusted; spores 5-7.5 x 1.8-4.3 μm 12
- 12 (11). Spores cylindrical, slightly curved, 5-6.5 x 1.8-2.6 μm . On conifers
18. Hymenochaete fuliginosa
- Spores ellipsoid or broadly ellipsoid. On angiospermic trees 13
- 13 (12). Hymenium usually with scattered low rounded tubercles; spores ellipsoid, 4.5-6 x 2.2-3.2 μm
20. Hymenochaete jobii
- Hymenium smooth; spores broadly ellipsoid, 5-7.5 x 3.5-4.3 μm
11. Hymenochaete cervina

3. KEY TO ALL SPECIES

1. Hymenophore distinctly warted or with teeth up to 2.5(-4) mm long (hydroid or odontoid) 2
- Hymenium smooth or with scattered low tubercles 5

- 2 (1). Basidiomata very soft when dry, easily detachable from substrate; in context and hymenium dichotomously branched hyphae or stellate astero-setae; mycelial strands at margin usually present; spores $1.8-4.5\ \mu\text{m}$ in width 3
- Basidiomata coriaceous or soft-coriaceous, closely adnate; dichotomously branched hyphae and asteroetae absent; mycelial strands absent; spores $5-6 \times 1.2-2.2\ \mu\text{m}$ 4
- 3 (2). Basidiomata effused; in context and hymenium numerous asteroetae; spores $4.5-7 \times 3.5-4.5\ \mu\text{m}$. Not found in southern USA (except AR) and Mexico
- 1. *Asterodon ferruginosus***
- Basidiomata effused-reflexed or effuse; in context numerous dichotomously branched hyphae; spores $3-4.2 \times 1.8-2.3\ \mu\text{m}$. Southern species, Mexico and to the South
- 2. *Dichochoete setosa***
- 4 (2). Tomentum absent, in old specimens cortex present as a black zone near substrate; setae numerous, $60-200 \times 8-15\ \mu\text{m}$
- 3. *Hydnochaete olivacea***
- Tomentum present as a cottony upper layer of the context; cortex present as a dark line; setae rare, present in the hymenium of the upper part of the teeth and between these, $25-55 \times 5-9\ \mu\text{m}$
- 4. *Hydnochaete tabacina***
- 5 (1). Basidiomata pileate, effused-reflexed or umbonate 6
- Basidiomata effused, margins sometimes slightly elevated 14
- 6 (5). Basidiome pileate, with a (sometimes branched) distinct stipe, 2-10 cm high; usually growing on ground near trees. Southern species, Mexico and to the South
- 15. *Hymenochaete damicornis***
- Basidiome always without a stipe, growing on wood 7
- 7 (6). Pileus flexible, soft; no cortex; hyphal layer well developed, with loosely arranged hyphae; spores cylindrical, slightly curved, $1.5-2.5\ \mu\text{m}$ broad . 8
- Pileus coriaceous or woody hard, not flexible; hyphal layer absent or when present, then hyphae more or less densely arranged and basidiome with a cortex; spores cylindrical or ellipsoid, $1.2-4.8\ \mu\text{m}$ broad 9
- 8 (7). Basidiomata effused-reflexed; setae few, in sterile hymenium numerous hyphidia with hook-like or coiled tips; spores $5.5-8.3\ \mu\text{m}$ long
- 14. *Hymenochaete curtisii***
- Basidiomata sessile-pileate or umbonate-sessile; setae scattered or numerous; no hyphidia with coiled or hook-like tips; spores $4.5-7\ \mu\text{m}$ long
- 25. *Hymenochaete rheicolor***
- 9 (7). Setae $4-8\ \mu\text{m}$ in diam. Southern species, Mexico and to the South 10
- Setae $7-15\ \mu\text{m}$ in diam 12
- 10 (9). Dendrohyphidia present; setal layer distinctly stratose; spores broadly ellipsoid, $5.2-6.5 \times 3.5-4.5\ \mu\text{m}$
- 17. *Hymenochaete escobarii***
- Dendrohyphidia absent; setal layer never distinctly stratose; spores subcylindrical to broadly ellipsoid, $3-5 \times 1.8-2.5\ \mu\text{m}$ 11
- 11 (10). Hyphidia absent; setae $20-40 \times 4-8\ \mu\text{m}$; spores $3-4(-4.5)\ \mu\text{m}$ long; hymenium brown, greyish or dark brown to blackish
- 9. *Hymenochaete cacao***
- Numerous brownish encrusted hyphidia with thickened walls present; setae $(25-40-60 \times 5-8\ \mu\text{m})$; spores $4-5(-5.5)\ \mu\text{m}$ long; hymenium greyish to

brownish orange, in old specimens rust brown

22. *Hymenochaete luteobadia*

- 12 (9). Basidiome woody hard; pileal surface velutinous, soon glabrous; hymenium not cracked or with few deep crevases when old; no setal hyphae; setae 40-80(-100) x 8-10(-12) μm , without incrustation; spores ellipsoid, with one side flattened, 3.8-5.5 x (1.8-)2-2.8 μm

27. *Hymenochaete rubiginosa*

- Basidiome coriaceous; pileal surface radially fibrose or coarsely hirsute, glabrous when old; setae (50-)60-150 x 7-15(-16) μm , with encrusted tip; spores cylindrical, slightly curved or allantoid, (4.3-)4.5-11(-13) x 1.2-2.7 μm 13
- 13 (12) Pileal surface radially fibrose and hairy; hymenium radially or plumosely densely cracked; setal hyphae usually present but not numerous, 120-250 μm long; setae (50-)60-120(-150) x 7-15(-16) μm , with finely encrusted tip; spores slightly curved, 4.5-7 x 1.2-2.2 μm

28. *Hymenochaete tabacina*

- Pileal surface coarsely hirsute; hymenium not cracked; setal hyphae absent; setae 80-150 x (9-)10-15 μm , in upper part or at tip encrusted with granules of polyhedric crystals; spores curved (allantoid), 8.5-11(-13) x 2.2-2.7 μm

5. *Hymenochaete allantospora*

- 14 (5). Dendrohyphidia absent 15
- Dendrohyphidia with thickened brownish walls, usually repeatedly branched; basidiome without tomentum but with cortex and hyphal layer, sometimes stratoze with alternating hyphal and setal layers

23. *Hymenochaete pinnatifida*

- 15 (14). Hyphal layer present (sometimes thin) 16
- Hyphal layer absent or indistinct, only (usually thickening) setal layer present 26

- 16 (15). Hyphal layer (seemingly) duplex, with a dark line in this layer.... 17

- Hyphal layer not duplex 18

- 17 (16). In sterile hymenium hyphidia with yellowish thickened walls; in hyphal layer setal hyphae absent; basidiome with a dark line (cortex) in context dividing it into two parts

21. *Hymenochaete leonina*

- Hyphidia always absent; setal hyphae infrequent, up to 150 μm long, 5-10 μm in diam; dark line in hyphal layer sometimes present

26. *Hymenochaete rigidula*

- 18 (16). Cortex present, sometimes thin (12-60 μm). Very rare southern species 19

- Cortex indistinct or absent 20

- 19 (18). Setae 70-100 x 8-12 μm , always encrusted with groups of crystals, or crystals forming a narrowly conical cap; basidiome 100-600 μm thick; spores cylindrical, slightly curved or sigmoid, (7-)7.5-9.2 x 2.5-3(-3.2) μm

6. *Hymenochaete americana*

- Setae 70-90(-95) x 7-9(-10.5) μm , without incrustation; basidiome up to 225 μm thick; spores broadly ellipsoid, 5-6 x 3.2-4 μm

19. *Hymenochaete fulva*

- 20 (18). Setae 30-60 μm long 21
 - Setae 55-120 μm long 23
 21 (20). Setae rare or scattered, fusiform; spores 3.5-5 x 1.8-2.5 μm ;
 hyphidia absent; basidiome thin (up to 230 μm), soft to coriaceous
16. Hymenochaete epichlora
 - Setae numerous, subulate to fusiform; basidiome 200-1000 μm thick,
 coriaceous to woody hard 22
 22 (21). Setal hyphae absent; spores 4-5 x 2.4-3.2(-3.5) μm ; hyphidia not num-
 erous, hyaline or yellowish **30. Hymenochaete unicolor**
 - Setal hyphae infrequent, up to 150 μm long and 4-10 μm in diam; spores
 3.7-5 x 1.5-2.3(-2.5) μm ; hyphidia absent **26. Hymenochaete rigidula**
 23 (19). Setae rare or scattered; spores cylindrical, slightly curved, 5.5-8.3 x
 1.5-2.5 μm ; hyphidia numerous, with hook-like or coiled tips in sterile
 hymenium **14. Hymenochaete curtisii**
 - Setae numerous; spores cylindrical or ellipsoid; hyphidia with coiled tips
 absent 24
 24 (23). Basidiomata strатose, with 2-10 distinct rows of setae and sometimes
 a thin hyphal layer between these, thickening (up to 1-2 mm), deeply
 cracked; spores short cylindrical, 4.5-6.5 x 1.8-2.8(-3.2) μm . Common
 species **12. Hymenochaete cinnamomea** ssp. **spreti**
 - Basidiomata not strатose, thin (up to 300, rarely 700 or 1000 μm), not
 deeply cracked; spores ellipsoid, 2.3-5.2 μm broad. Very rare species . 25
 25 (24). Spores broadly ellipsoid, 7-8 x 4.2-5.2 μm ; basidioles thin-walled, 5-8
 μm in diam **8. Hymenochaete burdsallii**
 - Spores ellipsoid, 4.8-6 x 2.3-3.3 μm ; basidioles with thickened walls, 3.5-5
 μm in diam **24. Hymenochaete rhabarbarina**
 26 (15). Setae 7-15 μm in diam, setal tip usually encrusted with crystals or
 amorphous granules. On angiospermic trees, rarely on conifers 27
 - Setae 5-11 μm in diam, without incrustation (in *H. opaca* encrusted in
 uppermost part) 30
 27 (26). Most setae with almost blunt tip, in upper part encrusted with
 granules; no hyphidia; spores cylindrical, slightly curved, 4-6.8 x 1.5-2.3
 μm 28
 - Setae usually with acute tip, in older basidiomata with encrusted with
 crystals upper part or tip; hyphidia absent or when present, then hyaline
 or brownish; spores 2.2-4.3 μm broad 29
 28 (27). Cortex absent but thin dense cortex-like layer of hyphae may be
 present; basidiome brownish or reddish grey, later sometimes dark brown.
 Common species **13. Hymenochaete corrugata**
 - Cortex 30-40 μm thick; basidiome yellowish brown to brown. Doubtful
 species, found only twice **31. Hymenochaete episphaeria**
 29 (27). Hymenium usually with scattered low tubercles; spores ellipsoid, 4.5-6
 x 2.2-3.2(-3.5) μm **20. Hymenochaete jobii**
 - Hymenium smooth; spores broadly ellipsoid, 5-7.5 x 3.5-4.3 μm
11. Hymenochaete cervina

- 30 (26). On bark or between bark scales of living angiospermic trees. Spores ellipsoid, (5-)5.5-6.5(-7) x (2.8-)3-3.5 μm ; most setae 50-90 x 6-10 μm , some setae 20-25 x 5.5-7 μm **10. Hymenochaete carpatica**
- Never on living trees. Spores cylindrical or ellipsoid, 1.5-2.6 μm in width; setae more or less of uniform size 31
- 31 (30). Setae 30-60 x 5-10 μm 32
- Setae 65-100 x 7-11 μm 33
- 32 (31). Basidioles hyaline, thin-walled; spores 4.5-5.5 x 2-2.5 μm ; some setae with slightly curved tips, sometimes some sinuate; no cystidia **29. Hymenochaete tenuis**
- Basidioles yellowish, encrusted with thin granules; spores 3.2-4(-4.5) x (1.5-)1.8-2.3(-2.5) μm ; setae usually flexuose; cystidia sometimes present, with thickly encrusted walls, 15-23 x 6-12(-15) μm **7. Hymenochaete anomala**
- 33 (31). Setae without incrustation; on wood of coniferous trees. Common in boreal forests, not found in southeastern USA or Mexico **18. Hymenochaete fuliginosa**
- Setae encrusted in uppermost part with small crystals; on wood of angiospermic trees. Described from Jamaica, mentioned (possibly erroneously) from AL, FL, LA and Mexico; dubious species **32. Hymenochaete opaca**

ASTERODONTACEAE

1. *Asterodon ferruginosus* Pat.

Figs. 3, 2; 6, 2

Pat., Bull. Soc. Mycol. France 10: 130 (1894); Corner, Trans. Brit. Mycol. Soc. 31: 235, f. 1-5 (1948); Parmasto, Lachnocladiaceae Soviet Union 121, 151, f. 88-95, 105 (1970). - *Hydnochaete setigera* Peck, Ann. Rep. New York St. Mus. 50: 113 (1897). - *Asterostroma ochrostoma* Burt, Ann. Missouri Bot. Gard. 11: 34 (1924).

Basidiome annual, effused, easily detachable from substrate, cottony soft, light weight, to 5 mm thick, round, 3-20 cm in diam (when confluent to 5 m long); context soft, loose, cottony, up to 1 mm thick. Hymenophore warted, soon composed of densely arranged teeth, bright Fulvous or Ochreous-Fulvous to Sienna (M: 7.5 YR 6/8, sometimes 5-7/6-8; K & W: (5-)6 C 7 or 6 C-D 6, brownish orange, caramel brown or cinnamon brown); teeth cylindrical-conical, (0.2-)0.5-2(-4) mm long, 0.12-0.3(-0.4) mm diam; margin 0.5-2 mm wide, thin, radially fibrillose or almost arachnoid, whitish, then concolorous with hymenophore, later disappearing; margin and rotten substrate with numerous, sometimes branched, soft, whitish, later brownish mycelial threads up to 0.7 mm in diam.

Tomentum and cortex absent; context composed of hyphal layer 200-1000 μm thick; dark line above the hymenium absent.

Hyphal system asteritrimitic with generative and skeletal hyphae, and asterosetae; setal hyphae present in teeth, 60-170 x 5-7 μm ; generative hyphae numerous, with thin hyaline or yellowish walls, septate, branched, 1.5-3 μm in diam; skeletal hyphae thick-walled, brownish, 1.5-3 μm in diam; asterosetae common, with 3-5(-7) unbranched rays, each 30-120(-150) x 5-8 μm , in subhy-

menium smaller than at substrate; hyphae in teeth more or less parallel; in hymenium crystalline matter absent.

Hymenial setae numerous, 40-80 x 5-10 μm , single or as sidebranches of setal hyphae, simple or with 2-4 sidebranches at base, 25-80 x 5-10 μm , projecting to 40 μm , subulate to fusiform, with acute tip, straight, naked, without incrustation.

Cystidia (cystidioles) not numerous, mainly situated on tip of a tooth, fusoid, with usually cylindric upper part, thin-walled, 20-50 x 4-6 μm ; hyphidia rare, hyaline, 1-2.5(-3) μm in diam. Basidioles present, without incrustation; basidia clavate, some slightly flexuose, 17-25(-30) x 5-7(-8) μm ; sterigmata 4, 4-5 μm long; spores broadly ellipsoid, with one side slightly flattened, with thin or slightly thickened walls, 5-6.5(-7) x 3.5-4.5 μm .

SUBSTRATA IN N. AMERICA. *Abies balsamea* (6), *A. lasiocarpa* (G & L, 1995), *Acer rubrum* (1), *Acer* sp. (1), *Betula alleghaniensis* (8), *B. papyrifera* (1), *Betula* sp. (4), *Fagus grandifolia* (3), *Fagus* sp. (2), *Picea engelmannii* (4), *P. glauca* (G & L, 1995), *P. rubens* (7), *Picea* sp. (3), *Pinus monticola* (1), *P. strobus* (2), *Populus grandidentata* (1), *Populus* sp. (2), *Pseudotsuga menziesii* (2), *Thuja plicata* (1), *Tsuga canadensis* (12), *T. heterophylla* (4), *Tsuga* sp. (8).

DISTRIBUTION IN N. AMERICA. CANADA: BC (1), NB (G & L, 1995), ON (5), PQ (1), YT (G & L, 1995). **USA:** AR (G & L, 1995), CT (G & L, 1995), DE (1), ID (11), MA (2), ME (8), MI (16), MT (8), NH (28), NY (17), VT (3), WA (1), WI (1).

DISTRIBUTION ELSEWHERE. Europe; Asia-Temperate: Russia (W. Siberia, S. Siberia incl. Altai and Sayani Mts.). - On rotten logs, under roots of old rotten stumps or in forest litter of mainly coniferous trees (*Abies*, *Larix*, *Picea*, *Pinus*).

REMARKS. Basidiomata of this species are sometimes growing over the remains of the last year ones, and seem to be strato-se. One of such specimens seen by me (collected in Vermilion, Michigan; BPI 325219) has 7 layers and is more than 15 mm thick. Development of microstructure in this species has been described in detail by Corner (1948). Parmasto (1970: 125) found that the first stage in development of skeletal hyphae and asterosetae from the generative hyphae is identical: after a septum, a brownish hypha with thickening walls begins to grow. After an interval of length equal with prospective rays of an asteroseta, growth stops in one case and an asteroseta will develop. In other cases, the growth of the hypha is unlimited and a skeletal hypha will be formed. Accordingly, skeletal hyphae and asterosetae are homologous in this species. **Misidentifications.** In herbaria, sometimes *A. ferruginosus* has been filed under the name *Tomentella crinalis* (Fr.) M.J. Larsen (*Thelephoraceae* s. str.)

CLAVARIACHAETACEAE

2. *Dichochaete setosa* (Sw.: Fr.) Parmasto

Figs. 3, 1; 5, 3

Parmasto, *Folia Crypt. Estonica* 37: 57 (2001). - *Thelephora setosa* Sw., *Fl. Indiae Occid.* 3: 1929 (1806); Fr., *Syst. Mycol.* 3, Index 189 (1832). - *Hydnochaete setosa* (Sw.) Lloyd, *Mycol. Writ.* 4, *Mycol. Notes* 41: 559, f. 766 (1916). - *Hydnum resupinatum* Sw., *Prodr.* 149 (1788). - *Hydnochaete resupinata* (Sw.) Ryvarden, *Myco-*

taxon 15: 437, f. 5 (1982); Corner, *Ad Polyporaceas* 7: 164, f. 39-42 (1991). - *Hymenochaete aspera* Berk. & M.A. Curtis, *J. Linn. Soc. Bot.* 10: 334 (1868); Burt, *Ann. Missouri Bot. Gard.* 5: 311, f. 2 (1918); Reeves & Welden, *Mycologia* 59: 1040, f. 1 J (1967); Léger, *Hymenochaete* 57, f. 10 (1998).

Basidiome effused, effuso-reflexed or resupinate with elevated margins, closely adnate but sometimes separable, cottony soft or papery when dry, 100-3000(-7000) μm thick. Pilei confluent, imbricate, flabelliform to dimidiate, (0.5-)1-3(-5) cm long and to 10 cm wide, flexible when dry; surface radiately strigose, rough with coarse fibers, or densely covered with entangled forked or corniculately branched hairs up to 4 mm long, with concentric zones, at base sometimes with long branched outgrowths, dark Sienna to Umber (M: 5-7.5 YR 4/4, 6/8 or 4/6-8; K & W: 6 E 7 or 6 D 5 - 6, cognac or sunburn to cinnamon brown); margin thin, entire to lacerate, sometimes long-fimbriate (up to 7 mm broad) or eroded at the edge, plicate, concolorous with the pileal surface. Hymenium granulose, colliculose, then warted or hymenophore irregularly hydroid; aculei pointed to rounded, scattered or in groups, up to 2 mm long, dark Sienna to light Umber (M: 5-7.5 YR 5/7-8, 5/5 or 4/6; K & W: 6 C 3 - 6 E 6-7, light brown to cocoa colour at the center; 6 B 4, greyish orange at the edges), without olive or lilac tint; margin of the resupinate part usually fibrillose, concolorous or lighter than hymenium, or with a darker zone; mycelial strands usually present at the margin and at base of the basidiome, up to 10 mm long, finger-like, sometimes brighter coloured.

Tomentum and cortex absent; context composed of hyphal layer, some darker hyphae agglutinated to form a thin darker band in some areas; sometimes in context hyphal threads 50-100 μm in diam; or of hyphal layer and a setal layer formed of overlapping rows of setae; dark line above the hymenium absent.

Hyphal layer 100-1000 μm thick, concolorous with other layers, cinnamon to rusty brown; context hyphae tightly interwoven but more loosely arranged towards the adaxial surface, often structure fibrillose with elongated cavities and hyphal threads 20-45 or up to 90 μm in diam, these longitudinally arranged or descending, curved outward toward the upper surface of the pileus.

Hyphal system dimitic with generative and dichohyphae; setal hyphae present in context and in pileal surface, up to 250 μm long, 4-10 μm in diam; generative hyphae 2-5 μm in diam, yellowish to brownish, thin- to thick-walled, septate, in the subhymenium hyaline and thin-walled; dichohyphae rare or abundant in the teeth, less common in the context but numerous at margin of the pileus, strongly dendroidly, dichotomously branched with mostly short sidebranches, yellow to hyaline; in context, setal stratum and hymenium crystalline matter absent.

Setal layer 40-100 μm thick (when present); setae uncommon to numerous, 40-80 x 5-10 μm , projecting to 30-40 μm , conical to fusiform, with acute tip, straight, naked or enmeshed in hyphal sheaths, without incrustation.

Dichotomous hyphidia abundant in the teeth, with mostly short sidebranches; dendrohyphidia present or absent (see above about dichohyphae); cystidia absent; basidioles present, without incrustation; basidia clavate or sub-

clavate, 8-15 x 3-5 μm ; sterigmata 4; spores broadly ellipsoid, 3-4.2 x 1.8-2.3 μm .

SUBSTRATA IN N. AMERICA. On dead wood of deciduous trees.

DISTRIBUTION IN N. AMERICA. MEXICO: VC (Córdoba, Matlaquihahuite, Dec 1854 Sallé, K; near Córdoba, 17 Jan 1910 W.A. & E.L. Murrill 1215, NY).

DISTRIBUTION ELSEWHERE. Mesoamerica: Costa Rica; **Caribbean:** Cuba, Dominica, Jamaica, Puerto Rico, Trinidad; **South America:** Argentina (Tierra del Fuego), Brazil, Chile, Colombia, Ecuador, Venezuela; **Asia-Tropical:** India (N. India and Bengal), Nepal.

TYPES STUDIED. *Thelephora setosa*: Jamaica, Swartz (K). *Hydnum resupinatum*: Jamaica, Swartz (K, lectotype selected by L. Ryvarden; K, S, isoelectotypes). *Hymenochaete aspera*: Cuba, Wright 211 (K; isoelectotypes: BPI 277592, FH, K, NY, S; paratypes: K).

REMARKS. Strigose pileal surface, granular to hydroid hymenium and dichotomous hyphidia similar to those in *Clavariachaete* and *Vararia* are the most important characteristics of this species.

HYMENOCHAETACEAE

3. *Hydnochaete olivacea* (Schwein.: Fr.) Banker Figs. 2, 4; 5, 17

Banker, Mycologia 6 (5): 234 (1914); Ryvarden, Mycotaxon 15: 433, f. 3 (1982); Jung, Wood-rott. Aphyll. s. Appal. 131, f. 41, pl. 16 C, 26 E; Gilb. & Ryvarden, N. Am. Polypores 1: 351, f. 168 (1986). - *Sistotrema olivaceum* Schwein.: Fr., Schr. Naturf. Ges. Leipzig 1: 101 (1822). - *Hydnum olivaceum* (Schwein.: Fr.) Fr., Elench. fung. 134 (1828). - *Sistotrema fuscescens* Schwein., Schr. Naturf. Ges. Leipzig 1: 102 (1822). - *Hydnoporia fuscescens* (Schwein.) Murrill, N. Am. fl. 9 (1): 3 (1907). - *Irpex cinnamomeus* Fr., Epicr. 524 (1838).

Basidiome annual (?), effused or effuso-reflexed, closely adnate, coriaceous, woody when dry, 500-2800 μm thick, round, 5-25 cm in diam; reflexed margin (pileus) short (up to 2 mm) and broad. Hymenophore warted or hydroid with irregular, round to flattened teeth, obtused to incised in the top, often antlerlike with a fused base; length of teeth 0.5-2.5 mm; hymenium not cracked, in fertile specimens Cinnamon or reddish Brown (M: 7.5 YR 5/6-10; K & W: 5 C 5-8, topaz to brownish yellow), rusty brown in sterile and old specimens (K & W: 6 D 7-8, light brown), without olive or lilac tint; resupinate margin fibrillose or abrupt, lighter coloured (M: 7.5 YR 8/6-8 to 7/10 when older), then concolorous with hymenium, pale cinnamon to rusty brown or ferruginous.

Tomentum and cortex absent, or cortex present in old specimens as a black zone next to the substrate; context composed of hyphal layer, or setal layer only with setae scattered throughout; dark line above the hymenium absent.

Hyphal layer to 300 μm thick, rusty brown, homogeneous (without a dark line); hyphal system dimitic; setal hyphae present; generative hyphae 1.5-3 μm in diam, yellowish, with thickened walls, moderately branched, with scattered septa; skeletal hyphae dominating, yellow to pale rusty brown, 3-5 μm in diam, thick- or very thick-walled to solid; there are also a few hyphae of transitional type with very rare septa; in context and hymenium crystalline matter absent.

Setae numerous, 60-200 x 8-15 μm , projecting to 50 μm , fusiform-subulate, with acute tip, straight, naked, without incrustation.

Hyphidia, cystidia and basidioles absent; basidia clavate or subclavate, 6-12 x 4-5 μm ; sterigmata 4; spores cylindrical to allantoid, 5-6 x 1.2-2 μm .

SUBSTRATA IN N. AMERICA. On dead branches, often still attached to the trees. *Acer rubrum* (G & L, 1995), *A. spicatum* (Jung, 1987), *Alnus incana* (incl. ssp. *incana* and ssp. *rugosa*) (G & L, 1995), *A. rubra* (1), *A. viridis* ssp. *crispa* (G & L, 1995), *Betula alleghaniensis* (G & L, 1995), *B. lenta* (G & L, 1995), *B. lutea* (Jung, 1987), *B. pumila* (G & L, 1995), *Carpinus caroliniana* (G & L, 1995), *Fagus grandifolia* (G & L, 1995), *Ligustrum* sp. (1), *Ostrya virginiana* (1), *Populus* sp. (G & L, 1995), *Prunus serotina* (G & L, 1995), *Pseudotsuga menziesii* (G & L, 1995), *Quercus alba* (1), *Q. coccinea* (1), *Q. marilandica* (1), *Q. nigra* (G & L, 1995), *Q. rubra* (syn.: *Q. borealis*) (3), *Q. velutina* (G & L, 1995), *Quercus* sp. (17), *Salix nigra* (G & L, 1995).

DISTRIBUTION IN N. AMERICA. CANADA: NB (G & L, 1995), NS (G & L, 1995), ON (5), PQ (7). **MEXICO:** VC (Jalapa, 1). **USA:** AL (G & L, 1995), AR (1), CT (4), FL (3), GA (G & L, 1995), ID (G & L, 1995), IL (G & L, 1995), IN (G & L, 1995), KY (G & L, 1995), LA (3), MD (1), ME (G & L, 1995), MI (G & L, 1995), MO (G & L, 1995), MS (1), MT (G & L, 1995), NC (7), NH (G & L, 1995), NJ (1), NY (G & L, 1995), OH (G & L, 1995), PA (Ryvarden, 1982; G & L, 1995), RI (1), SC (G & L, 1995), TN (6), TX (G & L, 1995), VA (G & L, 1995), VT (G & L, 1995), WA (1), WI (1), WV (G & L, 1995).

DISTRIBUTION ELSEWHERE. Caribbean: Jamaica; South America: Ecuador.

TYPE STUDIED. *Sistotrema olivaceum*: USA, Pennsylvania, Salem, 540 (UPS, isotype).

4. *Hydnochaete tabacina* (Berk. & M.A. Curtis) Ryvarden Figs. 2, 3; 5, 14

Ryvarden, Mycotaxon 15: 441, f. 7 (1982); Gilb. & Ryvarden, N. Am. Polypores 1: 353, f. 169 (1986); Corner, Ad Polyporaceas 7: 168, f. 43 (1991). - *Irpex tabacinus* Berk. & M.A. Curtis in Fr., Nova Acta Reg. Soc. Sci. Upsal. III 1: 106 (1851). - *Cerrenella tabacina* (Berk. & M.A. Curtis) Murrill, Bull. Torrey Bot. Club 32: 361 (1905).

Basidiome effused to effuso-reflexed, closely adnate, coriaceous when dry, up to 3000 μm thick. Pilei single or a few growing together, short and broad, when present reflexed part up to 0.6 cm long; pileal surface concentrically sulcate or not, tomentose but not radiately fibrillose or rugose, with concentric zones, dark cinnamon brown; margin entire, not plicate, concolorous with the pileal surface. Hymenophore hydnoid, azonate, cracked, dark Sienna, dark Cinnamon (M: 7.5 YR 5-8/10; K & W: 6 D 6-7, cinnamon brown to raw Sienna), in old specimens dark brown, without olive or lilac tint; teeth round and acute to flattened, often fused in basal parts, sometimes radially arranged, when immature sinuous and deeply incised, up to 2 mm long, 2-3 per mm; resupinate margin concolorous with hymenophore.

Tomentum present as the floccose or cottony upper layer of the context, up to 200 μm thick; cortex (30-)40-50(-100) μm thick; hyphal layer 200-300 μm

thick, hyphae interwoven; trama in the teeth distinctly paler, hyphae more parallel intertwined.

Hyphal system subdimitic; setal hyphae present; generative hyphae 2-4(-5) μm in diam, subhyaline to pale rusty brown, thin-walled or with thickened walls, septate, very rare in the context; skeletoids numerous in tomentum and hyphal layer but lacking or few in hymenophoral trama, dark rusty brown, 3.5-6 μm in diam, thick-walled; in context and hymenium crystalline matter absent.

Setae rare or not numerous, present in the hymenium in the upper part of the teeth, 25-55 x 5-9 μm , projecting to 30 μm , fusiform, with almost blunt tip, straight, often with slightly undulating walls, without sheaths or incrustation.

Hyphidia and cystidia absent; basidioles 4-5.5 μm in diam; basidia 13-20 x 4.5-6 μm , soon collapsing; spores cylindrical or allantoid, 5-6 x 1.5-2 μm .

SUBSTRATA IN N. AMERICA. *Quercus alba* (1), *Q. macrocarpa* (1), *Q. rubra* (syn.: *Q. borealis*) (1), *Q. virginiana* (1), *Quercus* sp. (3).

DISTRIBUTION IN N. AMERICA. USA: FL (12), GA (2), LA (2), MO (1), NC (3), SC (Ryvarden, 1982), TN (1).

DISTRIBUTION ELSEWHERE. Not found.

REMARKS. Mean size of spores was 5.28 x 1.78 μm ($Q = 2.96$) in the only specimen studied which has spores (TAA 151201, TN). The species has been lectotypified by Maas Geesteranus (1974) who selected *Curtis* 2358 (K). Subsequently Ryvarden (1982) designated *Curtis* 2356 (K) as lectotype.

5. *Hymenochaete allantospora* Parmasto

Fig. 6, 5

Parmasto, *Folia Cryptog. Estonica* 37: 58, f. 1, 1 (2001).

Basidiomata effuso-reflexed with small pilei 0.5-1 cm long, 200-500(-700) μm thick, resupinate part 1-3 cm in diam, then confluent; upper surface of pilei coarsely hirsute, indistinctly zonate, dark Umber (M: 7.5 YR 3-4/4; K & W: 6 E 6-7, later 6 F 7, dark brown). Hymenium smooth, sometimes concentrically sulcate, not cracked, fulvous Umber or dark Hazel (M: 7.5 YR 5/5, later 5 YR 6/4; K & W: 6 D 4-5, then 6 D 3, light brown to greyish brown = Café-au-lait), without olive or lilac tint; margin of the pileus slightly lobose or lacerate.

Tomentum well developed; cortex present; context composed of hyphal layer and (in old specimens) of setal layer; dark line above the hymenium absent or indistinct.

Tomentum 200-400(-600) μm thick, hyphae in ascending bundles, brownish, with thickened walls, 3.5-5 μm in diam; cortex 20-35(-45) μm thick, hyphae densely parallel, agglutinated, brown; hyphal layer up to 300 μm thick, hyphae densely longitudinally arranged but not agglutinated.

Hyphal system monomitic; hyphae with thickened walls, brownish, septate, rarely branching, 2.5-4 μm in diam; uncommon hyphae thin-walled and subhyaline; in hymenium crystals or granules of resinous brownish matter locally present.

Setae rare or uncommon, 80-150 x (9-)10-15(-16) μm , projecting up to 120 μm , subulate to fusiform, very easily breakable, with acute tip, straight, enmeshed in thin or thick hyphal sheaths, in upper part or at tip encrusted with granules of polyhedral crystals.

Cystidia absent; hyphidia numerous, cylindrical, thin-walled and hyaline, then brownish, with thickened walls usually encrusted with resinous granules or crystals, 2-3.5 μm in diam; basidioles not numerous, partly with slightly thickened and encrusted walls; basidia clavate-cylindrical, 20-25 x 5-6 μm ; sterigmata 4, 3-4 μm long; spores cylindrical, curved (allantoid), 8.5-11(-13) x 2.2-2.7 μm .

SUBSTRATA IN N. AMERICA. Unknown.

DISTRIBUTION IN N. AMERICA. MEXICO: VC (Rancho Santa Inés, km 1 of the Xalapa-Coatepec road, alt. 1330 m, 29 Mar 1990 V.M. Bandala, TAA 171364, holotype; XAL, isotype; near Xalapa, alt. 1330 m, 10 Dec 1990 D.M. Murietta 359, XAL; near Xalapa, 1750 m, 7 Jul 1994 A. García-Velázquez 394, XAL and TAA 171365).

DISTRIBUTION ELSEWHERE. Not found.

TYPE STUDIED. See above.

REMARKS. *H. allantospora* is externally similar to *H. tabacina* which has setae up to 120(-150) μm long and spores less than 7 μm long, and setal hyphae in context.

Mean spore size and *Q* value of the specimens studied:

9.36 x 2.33 4.02 (paratype, TAA 171365)

9.96 x 2.51 3.96 (holotype, TAA 171364)

6. *Hymenochaete americana* Greslebin & Parmasto

Figs. 4, 5; 6, 11

Parmasto, *Folia Cryptog. Estonica* 37: 59, f. 2 (2001).

Basidiomata resupinate, crustose, 100-600 μm thick, 1-3 cm in diam, then confluent. Hymenium smooth or with scattered rounded tubercles, slightly cracked, dark Vinaceous Buff to dark Fawn or chocolate brown (M: 5 YR 5/3 or 3-4/3-4; K & W: 6 D 4), without olive or lilac tint; margin broad (up to 2 mm wide), distinct, yellow-ochre or Sienna (M: 7.5 YR 5/8; K & W: 5 C-D 7, yellow ochre or golden brown), later not distinguishable from the hymenium.

Tomentum present but sometimes indistinct; cortex present; context composed of thin hyphal layer and later a stratose setal layer; dark line above the hymenium absent.

Tomentum 25-40 μm thick, hyphae loosely interwoven, brownish, with thickened walls, 4-5 μm in diam; tomentum in old specimens disappearing; cortex 20-60 μm thick, hyphae parallel densely agglutinated, brown; hyphal layer thin, hyphae more or less loosely, longitudinally arranged.

Hyphal system subdimitic; setal hyphae absent; generative hyphae 2-3.5 μm in diam, yellowish, with thickened walls; skeletoids brownish, 3-4.5 μm in diam; in context and hymenium crystalline matter locally present.

Setal layer 50-400 μm thick, indistinctly 1-3-stratose; setae not numerous or numerous, (60-)70-100 x 8-12 μm , projecting up to 70 μm , subulate to fusiform, with acute tip, straight, naked or rarely enmeshed in hyphal sheaths, always encrusted with small groups of polyhedral crystals, sometimes crystals forming a narrowly conical cap.

Cystidia and hyphidia absent; basidioles numerous, with slightly thickened walls; basidia clavate-cylindrical, 15-22 x 5-6 μm ; sterigmata 4, 4-5 μm long;

spores cylindrical, slightly curved, sometimes some almost sigmoid, (7.0-)7.5-9.2(-9.5) x 2.5-3(-3.2) μm .

SUBSTRATE IN N. AMERICA. *Quercus arizonica* (2).

DISTRIBUTION IN N. AMERICA. USA: AZ (Pima Co, Coronado Nat. Forest, Sycamore Canyon, 24 Sep 1970 and 21 Jan 1971 E.R. Canfield 56 and 7122, ARIZ).

DISTRIBUTION ELSEWHERE. Southern South America: Argentina (Tierra del Fuego), Brazil (Rio Grande do Sul).

TYPES STUDIED. Argentina, Tierra del Fuego, Estancia Moat, on *Drymis winteri*, 12 Nov 1999 A. Greslebin 2181 (TAA 166666, holotype; BAFC, isotype).

REMARKS. The possibly related *H. vaginata* G. Cunn. differs in having sometimes effused-reflexed basidiomata, numerous hyaline, yellow or brownish hyphidia and encrusted with small crystals or not encrusted large setae 90-160 x 9-14 μm ; it has been found once in New Zealand on *Phyllocladus alpinus* (Pinopsida, Podocarpaceae), and (a young specimen) in Hawaii. Isotype of that species (K) has only few, partly collapsed spores; these are (6-)6.8-8 x 2.4-3.2 μm (mean of 12 spores: 7.24 x 2.79 μm). If the two taxa are allopatric species or subspecies, their origin and distribution is possibly Gondwanan.

7. *Hymenochaete anomala* Burt

Figs. 2, 2; 5, 5

Burt, Ann. Missouri Bot. Gard. 5: 358 (1918); Reeves & Welden, Mycologia 59 (6): 1040, fig. 1 D (1967); Job, Mycol. Helvet. 4 (1): 6 (1990); Léger, Hymenochaete 55, f. 9 (1998).

Basidiomata effused, closely adnate, coriaceous to hard when dry, 50-200(-250) μm thick, 0.5-2 cm long, then confluent. Hymenium smooth or finely granulose, azonate, irregularly minutely cracked when old, Isabelline (M: 10 YR 6-7/4, later 5-6/6; K & W: 5 C 4-5, brownish orange, to 5 D 5-7, golden brown), with a slight olive tint, without a lilac tint; margin thin, slightly tomentose, then determinate, concolorous with hymenium or lighter coloured (K & W: 5 A 4).

Tomentum and cortex absent; context composed of hyphal layer and concolorous setal layer, sometimes setal layer seated on substratum and hyphal layer absent; setal layer composed of overlapping rows of setae; dark line above the hymenium absent.

Hyphal layer (when present) to 150 μm thick, hyphae compactly interwoven; hyphal system monomitic or subdimitic, without setal hyphae; generative hyphae 2-4 μm diam, yellowish, branched, with slightly thickened walls; skeletoids brownish, with thickened walls, 2-4 μm in diam; some crystals in context and in hymenium, clusters of reddish brown granules to 25 μm diam present.

Setal layer 60-120 μm thick; setae numerous, small, (20-)30-45(-50) x (4-)5-7(-8) μm , embedded or projecting to 15(-25) μm above the hymenium, subulate to fusiform, usually flexuose, with tip acute, naked, without incrustation.

Hyphidia absent; cystidia sometimes present, 15-23 x 6-12(-15) μm , cylindrical, with thin or thickened usually thickly encrusted walls; basidioles 4-5 μm in diam, yellowish, usually encrusted with small granules; intermediates

between cystidia and basidioles sometimes present; basidia clavate or subclavate, 15-20(-25) x 4-5 μm , sterigmata 4, 3-4 μm long; spores ellipsoid, one side flattened, 3.2-4(-4.5) x (1.5-)-1.8-2.3(-2.5) μm .

SUBSTRATE IN N. AMERICA. *Salix* sp. (1).

DISTRIBUTION IN N. AMERICA. USA: LA (St. Martin Parish, St. Martinsville, 14 Oct 1956 A.L. Welden 205, BPI 277530); MS (Harrison Co, Harrison Exper. Forest, 2 Dec 1989 H.H. Burdsall 13034, CFMR).

DISTRIBUTION ELSEWHERE. Mesoamerica: El Salvador; Caribbean: Cuba, Trinidad; South America: Argentina, Brazil, Venezuela.

TYPE STUDIED. Cuba, Managua, Earle & Murrill 36 (NY, holotype).

REMARKS. The 'cystidia' figured by Burt (1918, f. 26 c) and described as 16-20 x 6 μm are obviously encrusted hyphidia similar to those in *H. yasudai* Imazeki, many specimens of *H. cinnamomea* ssp. *spreti* and very conspicuously in *H. mollis* Bres. Cystidia are described as 6-12 μm in diam by Reeves & Welden (1967) and 7-11 μm in diam by Job (1990); on Fig. 1 D by Reeves & Welden (1967) they are figured as similar to basidioles. In the holotype the 'cystidia' are actually somewhat enlarged hyphal ends covered with agglomeration of crystals; they are hardly differentiated and not easily distinguishable.

8. *Hymenochaete burdsallii* Parmasto

Figs. 3, 6; 5, 16

Parmasto, *Folia Cryptog. Estonica* 37: 61, f. 1, 4 (2001)

Basidiomata effused, closely adnate, coriaceous when dry, as round patches 0.5-2.5 cm in diam, 40-150 μm thick. Hymenium smooth but in some places uneven (with very low tubercles), azonate, somewhat farinose, not cracked, dark Ochreous (M: 10 YR 6/8; K & W: 5 C-D 7), without olive or lilac tint; margin farinose-fibrillose, thin, when young about 1 mm wide, Luteous (M: 10 YR 7.5/10; K & W: 5 A-B 7), later disappearing and margin distinctly delimited

Tomentum and cortex absent, hyphal layer absent or indistinct, then 20-30 μm thick, hyphae densely interwoven but not agglutinated; setal layer with numerous hyphae; dark line above the hymenium absent; in hymenium conglomerates of brownish resinous matter or crystals up to 10 μm in diam.

Hyphal system monomitic; setal hyphae absent; generative hyphae brownish, with thin or thickened walls, (1.5-)2-3.2(-4) μm in diam.

Setae numerous but not crowded, subulate, with acute tip, straight, (50-)60-90(-95) x 5-9(-10) μm , projecting 30-50 μm , usually covered with a thin hyphal sheath.

Cystidia and hyphidia absent; basidioles numerous, hyaline, thin-walled, with rounded tip, 15-25 x 5-7(-8) μm ; basidia urniform, thin-walled, hyaline, 15-20(-25) x 6-7.5 μm , with 4 broad when young, then thin sterigmata about 4 μm long; spores broadly ellipsoid, thin-walled, hyaline, some with one side slightly flattened, (6.5-)7-8(-8.5) x 4.5-5.2(-5.5) μm .

SUBSTRATE IN N. AMERICA. *Ostrya virginiana* (2).

DISTRIBUTION IN N. AMERICA. USA: MI (Marquette Co, Big Bay, SE slope of Breakfast Roll, 10 Aug 1974 H.H. Burdsall 8272, CFMR, holotype; nearby, Lumbermanna cove, 9 Aug 1974 H.H. Burdsall 8252, CFMR, paratype)

TYPE STUDIED. See above.

REMARKS. Basidiomata of *H. burdsallii* are externally similar to *H. cinamomea* which has a well developed layer of loosely interwoven hyphae and short cylindrical or almost ellipsoid narrow spores 4.5-6.5(-7).x 1.8-2.8(-3.2) μm .

9. *Hymenochaete cacao* (Berk.) Berk.

Figs. 2, 1; 5, 2

Berk., J. Linn. Soc. Bot. 10: 333 (1868); Reeves & Welden, Mycologia 59 (6): 1041, f. 1 C (1967); Job, Mycol. Helvet. 4 (1): 10 (1990); Léger, Hymenochaete 79, f. 18 (1998). - *Stereum cacao* Berk., Hook. J. Bot. 6: 169 (1854).

Basidiome sessile-pileate, effuso-reflexed or seemingly effused but attached in midpoint and with slightly elevated margins (umbonate), closely adnate, hard or coriaceous but brittle when dry, 250-600(-2000) μm thick. Pilei single or a few growing together, sometimes confluent and imbricate, flabelliform or dimidiate, 1-3.5 cm long; pileal surface densely concentrically sulcate and zonate, velutinous or tomentose, yellowish brown, dark brown to blackish (M: 10 R 3-3.5/4; K & W: 5 B 2 - 6 E 8 or 6-7 E 6 - F 7, orange grey to hazel, almost chestnut or dark brown); margin lobate, plicate, concolorous with the pileal surface. Hymenium azonate, not or slightly cracked, brown, dark brown or blackish, usually somewhat greyish (M: 10 R 3-5/2 when with basidia; K & W: 5 E 3 or 6 E 4-6 G 8, greyish brown to purplish gray, sometimes 6 D 7), without olive or lilac tint; margin sometimes pale yellow (K & W: 4 A 3 or yellow orange).

Tomentum indistinct, 20-30 μm thick, or present as abhymenial hairs; cortex absent or sometimes only present as some agglutinated darker hyphae forming a thin dark band in some areas; context composed of hyphal layer and setal layer. Hyphal layer sometimes indistinctly duplex (upper part with very thick-walled hyphae); setal layer with overlapping rows of setae; dark line above the hymenium absent.

Cortex (when present) 20-30 μm thick, hyphae densely interwoven, agglutinated; hyphal layer 150-700 μm thick, concolorous with the setal layer; context hyphae longitudinally, not very compactly arranged, sometimes glued together.

Hyphal system monomitic; setal hyphae absent; generative hyphae 2.5-5 μm diam, yellowish to brownish, thick-walled; in hymenium of old specimens crystalline matter present.

Setal layer (40-)80-140 μm thick; setae numerous, 20-40 x 4-8 μm , projecting to 30 μm , fusiform, with stipe-like basal part (similar in form to metuloids of *Peniophora* species), straight, with tip acute, naked, without incrustation.

Cystidia and hyphidia absent; basidioles present, without incrustation; basidia clavate or subclavate, 8-12 x 3-5 μm ; sterigmata 4, 2-3 μm long; spores ellipsoid to broadly ellipsoid, 3-4(-4.5) x 1.8-2.5 μm .

SUBSTRATA IN N. AMERICA. Unknown.

DISTRIBUTION IN N. AMERICA. USA: NC (M.A. Curtis, BPI 277660). MEXICO: ? VC (Jalapa, Escobar 1978; the specimen in NY collected by W.A. & E.L. Murrill in 1909, no. 334 is very small and of somewhat doubtful identity).

DISTRIBUTION ELSEWHERE. **Mesoamerica:** Costa Rica, Mexico; **Caribbean:** Cuba, Guadeloupe, Jamaica, Puerto Rico; **South America:** Argentina, Brazil, Colombia, Venezuela; **Asia:** India (Eastern part), Indonesia (Amboina Is.), Malaya, Malaysia (Sabah), Nepal, ? Philippines, ? Singapore; **Australasia:** Australia. - Found on wood of angiospermic trees.

TYPES STUDIED. *Stereum cacao*: India, Khasia (K, holotype; LA, isotype); "authentic, Hook. Herb." (isotypes in BPI: 277664, 277665, 277667 and Lloyd Herb. 29713).

REMARKS. Setae similar to those in *H. cacao* are also characteristic for *H. luteobadia*, but that species differs in its grayish yellow hymenium and presence of thick-walled brownish hyphidia. Most of the Southeast Asian specimens seen by me in American herbaria are of doubtful identity: their setae are sometimes longer (to 50 μm); these, mainly old specimens may belong to *H. villosa* (Lév.) Bres.

10. *Hymenochaete carpatica* Pilát

Figs. 3, 5; 6, 9

Pilát, Hedwigia 70: 124 (1930); Baici & Léger, Mycol. Helvet. 3: 90 (1988); Rücker & Forstinger, Linzer Biol. Beitr. 23 (1): 417-424, f. 1-3 (1991); Léger, Hymenochaete 81, f. 19-20 (1998).

Basidiomata effused, closely adnate, corky (soft when young), 50-600(-800) μm thick, small, inconspicuous, at first 0.3-1 mm broad, rounded, then confluent and forming irregular patches to 10 cm long. Hymenium smooth, later irregularly deeply cracked, dark Ochreous, dark Fulvous or grayish Sienna when sporulating (M: 10 YR 6/8 to 7.5 YR 5-6/6; K & W: 5 C 6 to 6 D 5-6, Pompeian yellow to cinnamon brown), when sterile golden brown or brown (M: 5-7.5 YR 6.5/5, 5/8 or 4-5/4-6; K & W: 6 D-E 5 or 6 E 5-7, sunburn or cocoa brown), without olive or lilac tint, but sometimes dark reddish grey; margin thin, indistinct, whitish, soon abrupt, thick and concolorous with hymenium.

Tomentum indistinct or absent; cortex absent or indistinct; hyphal layer present in young specimens, later disappearing; setal layer with few or numerous rows of setae; dark line above the hymenium absent or present.

Cortex about 15 μm thick but absent in the majority of specimens, discontinuous in others; hyphae of the cortex few, very densely interwoven, dark reddish brown, thick-walled; hyphal layer to 100 μm thick. Context hyphae compactly agglutinated, erect, in subhymenium almost loosely interwoven.

Hyphal system monomitic; generative hyphae septate, 1-3 μm diam, yellowish brown, with thickened walls; crystalline masses or numerous crystals and brown resinous matter in context and hymenium present.

Setal layer 30-600(-800) μm thick, in old specimens indistinctly stratified; setae numerous, 50-90 x 6-10(-12) μm (sometimes there are also setae 20-25 x 5.5-7 μm), projecting 35-60(-70) μm , a few 2-rooted; subulate, with tip acute, straight, naked or ensheathed by thin-walled, hyaline hyphae about 1 μm diam, without incrustation.

Cystidia and hyphidia absent; basidioles with slightly thickened and yellowish at base walls, 15-25 x 3.5-4.5 μm ; basidia clavate or subclavate, 15-25 x 4-5.2 μm ; sterigmata 4, 4-5(-6) μm long; spores ellipsoid to broadly ellipsoid,

with one side flattened or sometimes slightly concave, (5-)5.5-6.5(-7) x (2.8-)3-3.5(-3.8) μm .

CULTURAL CHARACTERS. Léger & Lanquetin, 1996: 106.

SUBSTRATA IN N. AMERICA. Acer sp. (1), *Quercus alba* (3).

DISTRIBUTION IN N. AMERICA. USA: MD (Takoma Park, on bark of living maple, 19 Feb 1899 C.L. Shear 1096, BPI 277679, identified by E.A. Burt as *H. corticolor*); NY (Scarsdale, 26 Jul 1914 P. Wilson; Ulster Co, Glasco, 25 Aug 1914 P. Wilson; Greene Co, Vicinity of Green Lake, 3 Sep 1914 P. Wilson; all three on bark of living *Quercus alba*; NY).

DISTRIBUTION ELSEWHERE. Europe: Austria, Czechia, England, Germany, Slovakia, Switzerland; **Asia Temperate:** Russian Far East. - In Europe on bark of *Acer platanoides*, *A. pseudoplatanus* and *Ulmus procera*, in Asia of *Tilia manshurica*.

TYPE STUDIED. Slovakia, Kleine Karpathen, Glashütten, on *Acer platanoides*, Apr 1926 A. Pilát (K, isotype).

REMARKS. Basidiomata of this species are hardly remarkable growing on external and lateral sides of bark scales of living trees. The species is similar to *H. jobii* which differs in its habitat (never on living trees) and spores 4.5-6 x 2.2-3.2(-3.5) μm . *H. corrugata* may be similar to *H. carpatica*; it differs in short, encrusted in upper part with amorphous granules or rugose setae 35-80 x 7-13 μm and cylindrical spores 4-7 x 1.5-2.2 μm .

Possibly the species is widely distributed in Northern America but not yet noticed due to its inconspicuous appearance and unusual for *Hymenochaete* habitat on bark of living trees. Setal hyphae are absent in North American specimens but present in the Asian Far East, few, 4-6.5 μm diam and to 100 μm long; they were also noted in culture of the species by Léger & Lanquetin (1996).

Mean spore size and *Q* value of the specimens studied

5.81 x 3.12	1.86	(NY, NY, Wilson 3 Sep 1944)
6.25 x 3.03	2.06	(Russian Far East, TAA 107605)
6.30 x 3.60	1.75	(England, Ainsworth)

11. *Hymenochaete cervina* Berk. & M.A. Curtis Figs. 3, 8; 5, 15

Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 334 (1868); Burt, Ann. Missouri Bot. Gard. 5: 363 (1918); Reeves & Welden, Mycologia 59 (6): 1042, f. 1A (1967); Léger, Hymenochaete 86, f. 21 (1998) *p. p.* - *H. corticolor* Berk. & Ravenel, Grevillea 1: 165 (1873); Burt, Ann. Missouri Bot. Gard. 5: 339, f. 14 (1918); Reeves & Welden, Mycologia 59 (6): 1043 (1967).

Basidiome perennial, effused, sometimes with thickened (reflexed) blackish upper margin, closely adnate, woody hard when dry, indistinctly stratose when old, 100-700(-800) μm thick. Hymenium smooth, azonate, irregularly cracked when old, dark Hazel, Isabelline, light Umber to Umber (M: 5-7.5 YR 4/6 to 5/4; K & W: 5-6 C 4-5, 6 D 4, 6 E 8 or 6 D-E 6-7, light umber or hazel), Vinaceous Buff when with basidia and spores (M: 7.5 YR 6/4-6; K & W: 6 C 4), without olive or lilac tint; margin slightly tomentose when young, then thick, abrupt, concolorous with hymenium or darker (tobacco brown).

Tomentum and hyphal layer absent; cortex absent or a thin blackish band of dark hyphae next to the substratum; setal layer composed of setae in overlapping rows or arranged in irregular strata; dark line above the hymenium absent.

Hyphae of the cortex densely interwoven, thick-walled, about 3 μm diam; context hyphae compactly arranged, erect or descending, later cemented together.

Hyphal system monomitic; setal hyphae absent; generative hyphae 2-4 μm diam, subhyaline to brown, thin- to thick-walled, branched; in context and hymenium usually numerous crystals and aggregates of brown resinous matter 12-30 μm diam; in hymenium crystals usually present.

Setal layer 100-650 μm thick; setae numerous, 55-100 x 7-15 μm , projecting to 25, rarely to 60(-70) μm above the hymenium, subulate to long-conical, with almost blunt or acute tip, straight, at base grown together with a bundle of brown branched agglutinated hypha, enmeshed in hyphal sheaths (rarely naked), in older basidiomata with encrusted upper part.

Hyphidia absent or present (in old specimens difficult to find), cylindrical-filiform, 2-3 μm diam, hyaline to brownish, with thickened rough wall, very little projecting above the basidia; cystidia absent; basidioles present, encrusted or without incrustation; basidia subclavate or subutriform, (15-)20-25 x 5-7 μm ; sterigmata 4, 3-4.5 μm long; spores broadly ellipsoid to short cylindric, one side flattened, 5-7.5 x 3.5-4.3 μm .

CULTURAL CHARACTERS. Job, 1986: 224.

SUBSTRATA IN N. AMERICA. *Fagus grandifolia* (1), *Magnolia grandiflora* (1), *Magnolia* sp. (1), *Prosopis glandulosa* (2), *Quercus alba* (2), *Q. gambelii* (1), *Quercus* sp. (2), ? *Rhododendron maximum* (1), *Ulmus* sp. (1).

DISTRIBUTION IN N. AMERICA. MEXICO: VC (Jalapa, 1). **USA:** AZ (2), FL (5), GA (1), IL (1), LA (2), MD (Burt, 1918 p.p.), NJ (1), NM (1), NY (2), SC (1), TN (1), VA (2).

DISTRIBUTION ELSEWHERE. **Mesoamerica:** Costa Rica. **Caribbean:** Cuba, Grenada, Jamaica; **South America:** Argentina, Brazil, Ecuador, Paraguay, Uruguay; **Africa:** ? Uganda; **Australasia:** New Zealand. - On many unknown substrata, in New Zealand on *Nothofagus fusca*.

TYPES STUDIED. *H. cervina*: Cuba, Wright 213 (FH, holotype; BPI, Lloyd Herb. 29422, isotype). *Corticium corticolor*: USA, South Carolina (Ravenel, Fungi Carol. Exs. III 30 as *H. corticola*, lectotype selected by L  ger, NY; isotypes in BPI).

REMARKS. Hyphidia are sometimes absent, or difficult to see in the basidiomata of *H. cervina* when covered with brown resinous matter; their tips may seem to be shortly branched but this is caused by agglomerates of the resinous matter. L  ger observed hyphidia in the (iso)type specimen of *H. cervina* (K); however, the author of this paper was unable to distinguish these in the holotype (FH). Encrusted cystidia figured (f. 29, b) but not described by Burt (1918: 363) and mentioned shortly by Reeves & Welden were not seen by me nor by Job (1990: 12).

There are three very closely related species in Northern America, Mesoamerica and Caribbean which may form very thick effused, externally almost identical basidiomata. *H. unicolor* (found in Caribbean area and Mesoamerica)

has much smaller setae (25-)40-60 x 5-7.5 μm , short spores (3.5-)4-5 x 2.4-3.2(-3.5) μm , and a sometimes hardly remarkable thin hyphal layer 10-100 μm thick. *H. jobii* has short narrowly ellipsoid spores 4.5-5.5 x 2.2-3.2 μm similar to these in *H. unicolor*, but setae similar to those in *H. cervina*, (50-)65-110(-120) x 7-12(-15) μm , and uneven hymenium with scattered low tubercles. Specimens of *H. cervina* and *H. jobii* are almost indistinguishable when without basidia and spores. **Misidentifications.** Some specimens of this species have been misidentified in herbaria as *H. corrugata*.

12. *Hymenochaete cinnamomea* (Pers.: Fr.) Bres. Figs. 4, 5; 5, 20

Bres., Atti Accad. Sci., Lett. Arti Agiati III 3 (1): 110 (1897); Burt, Ann. Missouri Bot. Gard. 5: 345, f. 17 (1918); Jahn, Westfäl. Pilzbr. 8 (4-7): 139, f. 25 (1971); Léger, Hymenochaete 91, f. 93 (1998). - *Thelephora cinnamomea* Pers.: Fr., Myc. Eur. 1: 141 (1822). - *Hymenochaete unicolor* s. auct. Amer. non Berk. & M.A. Curtis. - *H. simulans* s. Peck (1897) non Bres. - *H. spreata* Peck, Ann. Rep. N. Y. State Mus. 30: 47 (1878). - *Hymenochaetella arida* P. Karst., Bidr. Känned. Finl. Nat. Folk 48: 428 (1889). - *Hymenochaete arida* (P. Karst.) Sacc., Syll. fung. 9: 228 (1891); Burt, Ann. Missouri Bot. Gard. 5: 340, f. 15 (1918); Gilb. & Lindsey, Great Basin Naturalist 38 (1): 42, f. 1-3 (1978).

H. cinnamomea ssp. *spreata* (Peck) Parmasto

Parmasto, Folia Cryptog. Estonica 37: 62 (2001). - *H. spreata* Peck, Ann. Rep. N. Y. State Mus. 30: 47 (1878); Burt, Ann. Missouri Bot. Gard. 5: 348, f. 19 (1918); Pilát, Hedwigia 70 (1/2): 115 (1931); Jung, Wood-rott. Aphyll. s. Appal. 137, f. 43 j-m, pl. 27 B (1987).

Basidiomata effused, loosely adnate and separable, soft but not waxy, coriaceous or brittle when dry, (50-)200-1000(-2000) μm thick, confluent and then up to 25 cm long. Hymenium smooth, azonate, not cracked when very young, then densely, later deeply irregularly cracked, Cinnamon, then dark Sienna to Cinnamon Umber or reddish brown (M: 7.5 YR 4.5-5/6-8, sometimes 2.5 YR 4-5/4-5 or 7.5 YR 6/9; K & W: 6-7 D 6-8 or 7 D-E 7-8, cinnamon to light brown or brick red), without an olive or lilac tint; margin thin, indeterminate, later distinct, concolorous with the hymenium.

Tomentum and cortex absent; context composed of a hyphal layer and a setal layer with 1-10 more or less distinct rows of setae; sometimes between the rows a thin intermediate hyphal layer to 30(-60) μm thick composed of densely, sometimes partly loosely interwoven hyphae; dark line above the hymenium absent. Basal hyphal layer 20-150(-250) μm thick, lighter coloured than setal layers or concolorous; hyphae loosely arranged, interwoven.

Hyphal system monomitic; setal hyphae absent; generative hyphae distinct, 2-4.5 μm diam, yellow to brownish, with thickened walls, branches diverging at a right angle, with numerous septa; in context, setal stratum and hymenium crystalline matter absent.

Setae numerous, (60-)70-120(-150) x 5-9(-10) μm , projecting to 90 μm , subulate, usually some slightly curved, naked or enmeshed in hyphal sheaths, without incrustation, tips acute or very sharp; hyphae between setae vertically arranged, short-celled.

Hyphidia absent but basidioles may simulate thick-walled hyphidia; cystidia absent; basidioles septate, 15-30 x 3.5-5 μm , usually yellowish, later walls often thickened at base, yellow or brownish and granulose; basidia subclavate or subutriform, 15-30 x 3.8-6 μm , sometimes with thickened basal walls; sterigmata 4, 4-5 μm long; spores short cylindrical, some slightly curved, or almost ellipsoid with one side flattened, 4.5-6.5(-7) x 1.8-2.8(-3.2) μm .

Causes a white rot of wood.

SUBSTRATA IN N. AMERICA. *Abies balsamea* (1), *A. grandis* (2), *Abies* sp. (1), *Acer circinatum* (2), *A. macrophyllum* (1), *A. rubrum* (3), *A. saccharinum* (syn.: *A. dasycarpum*) (1), *A. saccharum* (3), *A. spicatum* (1), *Acer* sp. (9), *Alnus rubra* (syn.: *A. oregona*) (2), *A. incana* ssp. *rugosa* (4), *A. incana* ssp. *tenuifolia* (1), *A. viridis* ssp. *crispa* (Niemelä, 1985), *Alnus* sp. (6), *Artemisia tridentata* (1), *Betula alleghaniensis* (syn.: *B. lutea*) (4), *B. populifolia* (1), *Betula* sp. (1), *Carpinus* sp. (1), *Carya illinoensis* (1), *Ceanothus fendleri* (1), *C. velutinus* (4), *Ceanothus* sp. (2), *Chilopsis linearis* (1), *Cornus florida* (1), *Corylus americana* (1), *Crataegus brevispina* (= ?) (1), *Fagus grandifolia* (11), *Fagus* sp. (6), *Fraxinus nigra* (2), *Fraxinus* sp. (1), *Juglans cinerea* (1), *Juniperus deppeana* (1), *Liquidambar styraciflua* (1), *Liriodendron tulipifera* (3), *Maclura pomifera* (1), *Magnolia grandiflora* (1), *Magnolia* sp. (3), *Ostrya virginiana* (2), *Ostrya* sp. (1), *Picea glauca* (1), *P. x lutzii* (1), *P. rubra* (1), *Pinus aristata* (including var. *longaeva*) (1), *P. ponderosa* (1), *Platanus occidentalis* (1), *Populus tremuloides* (2), *Populus* sp. (4), *Prosopis glandulosa* (1), *Prunus serotina* (2), *Prunus* sp. (1), *Pseudotsuga menziesii* (1), *Quercus agrifolia* (5), *Q. arizonica* (1), *Q. emoryi* (2), *Q. gambelii* (3), *Q. hypoleucoides* (4), *Q. nigra* (1), *Q. rubra* (1), *Quercus* sp. (12), *Rhododendron* sp. (3), *Ribes floridum* (= ?) (1), *Ribes* sp. (2), *Rosa canina* (1), *Salix planifolia* (Niemelä, 1985), *Salix* sp. (1), *Sequoia sempervirens* (1), *Symphoricarpos occidentalis* (G & L, 1995), *Taxodium* sp. (1), *Thuja occidentalis* (2), *T. plicata* (14), *Thuja* sp. (1), *Tsuga heterophylla* (1), *Tsuga* sp. (1), *Umbellularia californica* (1), *Vaccinium arboreum* (3), *Vitis vinifera* (1), *Vitis* sp. (1).

DISTRIBUTION IN N. AMERICA. Northernmost localities are in Alaska, Yukon Terr., Labrador Peninsula (Quebec, 55.3° N, 77.8° W), Newfoundland and South Greenland. Widely distributed in USA, but more rare in South-East; only one locality known from Mexico. **CANADA:** BC (11), MB (2), NF (Niemelä, 1985), NS (2), ON (17), PQ (1), YT (1). **GREENLAND:** southernmost part S of 61°15' N. (Knudsen, Hallenberg & Mukhin, 1993). **MEXICO:** OA (1). **USA:** AK (5), AL (2), (South) AZ (18), CA (15), CO (2), CT (3), DC (1), FL (5), GA (1), ID (11), IL (2), IN (1), KS (2), KY (4), LA (6), MA (3), MD (9), MI (16), MN (3), MO (1), MS (5), MT (9), NC (12), ND (1), NE (2), NH (8), NJ (5), NM (2), NY (45), OH (4), OR (14), PA (2), SC (2), TN (18), UT (2), VA (2), VT (4), WA (14), WI (1), WV (17).

DISTRIBUTION ELSEWHERE. Not found in other regions, but ssp. *cinnamomea* has been observed in: **Caribbean:** Cuba; **Southern America:** Argentina, Brazil, Colombia, Ecuador; **Europe:** common in all countries; **Africa:** Macaronesia, Northern Africa, West-Central and East Tropical Africa, Southern Africa; **Asia-Temperate:** Israel, Caucasus, Middle Asia, Siberia, Russian Far East, Turkmenistan, China, Japan; **Australasia:** New Zealand. Data on occurrence in Australia are doubtful. - On numerous species of angiospermic and (more rarely) gymnospermic trees.

TYPES STUDIED. *H. spreta*: New York, Albany Co, Helderberg Mts., on Acer, Oct 1875 C.H. Peck (NYS, holotype; NY, isotype). *H. arida*: Finland, P. Karsten 809 (H, holotype).

REMARKS. Subspecies *cinnamomea* of this species differs in having distinctly alternating hyphal and setal layers with hyphal layer 50-200 μm thick and composed of loosely interwoven hyphae; hymenial surface is of lighter colour, not cracked or with few cracks. Externally similar *H. epichlora* differs with its non-layered basidiomata, shorter setae (30-60 x 4.5-9 μm) and ellipsoid spores 3.5-5 x 1.8-2.5 μm . Setae of ssp. *spreta* are of variable size within one specimen, but there are always present setae 80 μm or more in length.

There are two additional species macroscopically similar to *H. cinnamomea* basidiomata. *H. rhabarbarina* has similar structure but ellipsoidal spores with mean spore width more than 2.6 μm and mean spore length/width coefficient *Q* less than 2.1. The other differences are described at this species. *H. burdsallii* is characterized by absent or indistinct hyphal layer and broad ellipsoidal spores (6.5-7-8(-8.5) x 4.5-5.2(-5.5) μm).

Young specimens of ssp. *spreta* lack a thickened setal layer (hymenium) and are of light colour; such specimens are indistinguishable from ssp. *cinnamomea* and have been named *H. arida* in N. American herbaria. Somewhat older specimens may have a few setal layers with a very thin layer of densely intertwined hyphae between these; colour is darker and hymenium slightly cracked; these have usually been called *H. cinnamomea*. Most of the specimens have stratified setal layer as described above; in some old specimens collected mainly in Canada and the States of New York, West Virginia, Idaho, Kansas and California, two or three of the setal layers have a hyphal layer to 100 μm thick between these, and in other part of the basidiome the setal strata are without an intermediate hyphal layer. However, *spreta*-type of basidiome structure is absent in specimens collected in Europe or Asia. The dark(er) colour and deeply fissured hymenium in ssp. *spreta* is caused by the structure of basidiomata; presence of soft intermediate hyphal layers protects hymenium from cracking in ssp. *cinnamomea*.

Differing from most species of *Hymenochaete*, about a half of the specimens of *H. cinnamomea* studied have numerous spores. Obviously, sporulation period is very long in this species.

Misidentifications. In herbaria, some specimens of *H. cinnamomea* ssp. *spreta* have been filed under the name *H. rhabarbarina* and several under *H. corrugata*. The basidiomata of these species are sometimes externally similar (brown, densely cracked), but the structure is very different in *H. corrugata*: hyphal layer is absent, setae are broad (35-80(-100) x (6-)-7-13(-15) μm) and encrusted or rugose in upper part. - For *spreta*, three names have been used erroneously since the early 1900s: *Corticium simulans* Berk. & Rav. nom. nudum and based on this name *Hymenochaete simulans* (Berk. et Rav.) Peck, 1897 non (Berk. & Broome) Bres., 1896, and *H. unicolor* which is a species of southern distribution characterized by short setae (25-)40-60 μm long and ellipsoid spores 4-5 x 2.4-3(-3.5) μm

13. Hymenochaete corrugata (Fr.: Fr.) Lév.

Figs. 2, 11; 6, 6

Lév., Ann. Sci. Nat. III 5: 152 (1846); Burt, Ann. Missouri Bot. Gard. 5: 358 (1918); Coker, J. Elisha Mitchell Sci. Soc. 36 (3 & 4): 167, pl. 32 (1921); Reeves & Welden, Mycologia 59: 1042, f. 1 F (1967); Léger, Hymenochaete 100, f. 26 (1998). - *Thelephora corrugata* Fr.: Fr., Observ. mycol. 1: 154 (1815). - *Hymenochaete insularis* Berk., Grevillea 1: 165 (1873) *nom. nud.* - *Hymenochaete agglutinans* Ellis, Bull. Torrey Bot. Club 5: 46 (1874); Burt, Ann. Missouri Bot. Gard. 5: 344 (1918); Coker, J. Elisha Mitchell Sci. Soc. 36 (3 & 4): 168 (1921).

Basidiomata effused, closely adnate, hard when dry, 200-600 μm thick. 0.5-3 cm diam, then confluent and to 30 or more cm long. Hymenium smooth or minutely granulose, azonate, minutely irregularly cracked (rarely not cracked), brownish or reddish grey, sometimes with rosy tint, or dark brown or blackish (M: 2.5 YR 4.5, 10 R 5.5/2 to 2.5 YR 5.5/2, 10 R 2.5/4 to 2.5 YR 3/4; K & W: 7 E 5, 7-8 D 3, 7 E-F 6), without an olive tint; margin thin, indeterminate, fibrillose or tomentose, 0.2-0.7 mm wide, whitish, then concolorous with the hymenium, later as a narrow brown border.

Tomentum absent; cortex absent, but thin dense cortex-like hyphal layer may be present; context composed of setal layer composed of overlapping rows of setae; dark line above the hymenium absent. Basal hyphal layer 10-40 μm thick; context hyphae compactly agglutinated, erect or interwoven.

Hyphal system monomitic; setal hyphae absent; generative hyphae 2.2-4.2 μm diam, brownish to brown, thick-walled, septate, branched; in context and hymenium crystalline matter absent.

Setal layer 200-550 μm thick; setae numerous, 35-80(-100) x (6-)/7-15(-17) μm , projecting to 50(-60) μm above the hymenium, conical to almost fusiform, at base surrounded with a node of agglutinated hyphae, with blunt or almost acute easily broken tip, straight, naked, in upper part always encrusted with scattered amorphous granules or rugose.

Hyphidia and cystidia absent; basidia clavate or subclavate, 15-22 x 3.5-4.5 μm ; sterigmata 4, 4-5 μm long; spores cylindrical, slightly curved, 4.5-6.8(-7) x 1.5-2.3 μm .

Sterile state (*H. agglutinans* Ellis; *H. corrugata* f. *conglutinans* Bourdot & Galzin, Hymen. Fr. 393, 1928) forms effused round patches 1-3(-5) cm in diam on living branches where they bind these together in contact zone. The mycelial pad is up to 2 mm thick, concentrically sulcate, yellowish cream, grey-cinnamon in centre, later brownish. Hyphae densely interwoven, thick-walled, 2-4 μm in diam; scattered setae present, similar to the hymenial ones. Sterile state is rarely growing together with basidiomata, but in many cases separately, and can continue their growth after branches are dead already.

Causes white rot of wood.

CULTURAL CHARACTERS. Nobles, 1948: 339, 1965: 1134.

SUBSTRATA IN N. AMERICA (*agglutinans* state mentioned by an asterisk *). Found on more than 70 species of trees and bushes. Of more than 200 specimens with host data seen, only four have been found on gymnospermic substrata. - *Abies balsamea* (1), *Acer circinatum* (1), *A. negundo* (G & L, 1995), *A. nigrum* (G & L, 1995), *A. pensylvanicum* (G & L, 1995), *A. rubrum* (10+5*), *A. saccharinum* (1+1*), *A. saccharum* (1+3*), *A. spicatum* (4+7*), *Acer* sp. (20), *Aesculus* sp. (G & L, 1995),

Alnus incana (5+2*), *A. incana* ssp. *rugosa* (3+1*), *A. incana* ssp. *tenuifolia* (1*), *A. serrata* (6+2*), *Alnus* sp. (3+3*), *Amelanchier alnifolia* (2), *A. canadensis* (1+1*), *Amelanchier* sp. (1), *Ampelopsis arborea* (syn.: *Vitis bipinnata*) (2), *Andromeda* sp. (Ellis, 1874), *Betula alleghaniensis* (syn.: *B. lutea*) (2), *B. lenta* (2), *B. nigra* (1*), *B. papyrifera* (G & L, 1995), *B. populifolia* (1), *Betula* sp. (4+2*), *Carpinus caroliniana* (1+2*), *Carpinus* sp. (2), *Carya glabra* (1), *C. ovata* (1*), *Carya* sp. (3+3*), *Castanea sativa* (1), *Castanea* sp. (1+1*), *Celtis* sp. (1), *Clethra* sp. (1*), *Cornus stolonifera* (3), *Cornus* sp. (1*), *Corylus cornuta* (syn.: *C. rostrata*) (2+1*), *Crataegus* sp. (1), *Fagus americana* (6), *F. atropunica* (1*), *F. ferruginea* (2), *F. grandifolia* (14+5*), *Fagus* sp. (19), *Fraxinus americana* (1*), *F. nigra* (1*), *Hamamelis virginiana* (3+3*), *Ilex verticillata* (3), *Juniperus virginiana* (1), *Laurus* sp. (1), *Lindera benzoin* (2+1*), *Liquidambar styraciflua* (4), *Magnolia fraseri* (2), *Magnolia* sp. (1), *Malus pumila* (1), *Nerium oleander* (1), *Nyssa* sp. (1), *Ostrya virginiana* (1+1*), *Pinus strobus* (? 2*), *Platanus* sp. (1), *Populus grandidentata* (G & L, 1995), *P. tremuloides* (2), *Prunus caroliniana* (1), *P. pensylvanica* (4*), *P. serotina* (2), *P. virginiana* (1+1*), *Prunus* sp. (2+1*), *Quercus alba* (2+1*), *Q. coccinea* (1*), *Q. digitata* (= ?) (1*), *Q. ilicifolia* (1), *Q. nigra* (G & L, 1995), *Q. rubra* (G & L, 1995), *Quercus* sp. (13+1*), *Rhododendron maximum* (8), *Rhododendron* sp. (5+1*), *Salix bebbiana* (1), *S. nigra* (1), *Salix* sp. (1), *Thuja occidentalis* (G & L, 1995), *T. plicata* (G & L, 1995), *Tilia americana* (1), *Toxylon pomiferum* (1), *Tsuga canadensis* (1), *Vaccinium* sp. (1), *Vernicia fordii* (1), *Viburnum dentatum* (1), *V. lantanoides* (1), *Viburnum* sp. (1), *Vitis aestivalis* (2), *V. vulpina* (1), *Vitis* sp. (2).

DISTRIBUTION IN N. AMERICA. Found mainly in South-East and East parts of the USA; no data on occurrence in Mexico. The *agglutinans* state (mentioned by an asterisk *) is distributed mainly in the North-East of the USA. **CANADA:** MB and NB (G & L, 1995), NS (1), ON (11+2*), PE (G & L, 1995), PQ (1+1*). **USA:** AL (8+1*), AR (G & L, 1995), AZ (G & L, 1995), CT (6+18*), DC (1+2*), DE (4+3*), FL (21), GA (3), ID (1*), IL (1), IN (3), KY (6), LA (14), MA (18+7*), MD (26+2*), ME (11+8*), MI (6), MN (G & L, 1995), MO (1), MS (10), MT (G & L, 1995), NC (29+2*), NH (16+14*), NJ (16+6*), NY (51+9*), OH (6+1*), PA (16+3*), RI (1+3*), SC (6), TN (22), TX (5), VA (18+5*), VT (2+2*), WA (2), WI (1+1*), WV (6).

DISTRIBUTION ELSEWHERE. **Mesoamerica:** Costa Rica; **Caribbean:** Jamaica, Puerto Rico; **South America:** Argentina, Brazil, Ecuador, Uruguay; **Europe:** Austria, Belgium, France, Germany, Italy, Switzerland, Ukraine, United Kingdom; **Northern Africa:** Tunisia; **Southern Africa:** **Asia-Temperate:** China, Japan, Russia (Siberia), Taiwan; **Australasia:** New Zealand; **North-Central Pacific:** Hawaii. - On numerous angiospermic hosts. Sterile state ("*H. agglutinans*") has been found in Europe (England, France) where it is very rare.

TYPE STUDIED. *H. agglutinans*: New Jersey, Newfield (NY, holotype).

REMARKS. *H. agglutinans* has been synonymized with *H. corrugata* by Reeves & Welden (1967: 1042-1043); presence of this sterile state is a sign that the species may be called facultative parasite (cf. Graves, 1914). Macroscopically sometimes similar *H. cinnamomea* ssp. *spretta* differs from *H. corrugata* by presence of hyphal layer(s) and with long sharp, never incrustated setae (60-)70-120(-150) x 5-9(-10) μ m. **Misidentifications.** In herbaria, filed under the

name of *H. corrugata* are specimens of *H. pinnatifida* or *H. cinnamomea* ssp. *spreta*, sometimes also *H. curtisii* or *H. jobii*.

14. *Hymenochaete curtisii* (Berk.) Morgan

Figs. 3, 7; 6, 8

Morgan, J. Cincinnati Soc. Nat. Hist. 10: 197 (1888); Burt, Ann. Missouri Bot. Gard. 5: 320, f. 7 (1918); Coker, J. Elisha Mitchell Sci. Soc. 36 (3 & 4): 167, pl. 19, 32 f. 11-12 (1921); DeFigio, Tax. anal. 25, f. 6, pl. 2 f. 6a (1970); Jung, Wood-rott. Aphyll. s. Appal. 136, f. 43 a-e, pl. 27 A (1987); Chamuris, Non-stipit. stereoid fungi 156, f. 58 C (1988); Léger, Hymenochaete 110, f. 30 (1998). - *Stereum curtisii* Berk., Grevillea 1: 164 (1873).

Basidiome effused to effuso-reflexed or with slightly elevated margins, attached with umbos, adnate but separable, soft or soft coriaceous and flexible but not waxy when dry, 100-500 μm thick, orbicular, confluent and then to 20 x 2.5 cm. Pilei short and broad, to 0.8 cm long; pileal surface concentrically (sometimes indistinctly) sulcate, sometimes radiately fibrillose, silky, glabrous when old, with zones, brown (M: 5 YR 4/4-2, when old 5 YR 5/1; K & W: 5 C 2 or 5-6 C 3 to 5 D 4, 6 D 5-6, brownish orange to light brown, later grayish); margin lighter coloured than pileal surface (yellowish brown). Hymenium smooth or velvety, azonate, not cracked, golden brown or greyish brown (M: 7.5 YR 5/2; K & W: 6 D 4-6, 6 E 3-4 or 6 E 5-8, yellowish brown or light brown), when sterile Sepia or vivid Umber (M: 7.5 YR 3/6, K & W: 7 E 7), without an olive or lilac tint; context darker than hymenium; margin cinnamon brown when young (M: 7.5 YR 4-5/6), then concolorous.

Tomentum present, cortex indistinctly present; context composed of hyphal layer; dark line above the hymenium absent.

Tomentum 50-100 μm thick; cortex thin, composed of darkened thick-walled densely compacted hyphae; hyphal layer 80-450 μm thick, hyphae compactly longitudinally arranged or interwoven, but not glued together.

Hyphal system monomitic; setal hyphae absent; generative hyphae 2-4 μm diam, subhyaline to brownish, with thickened walls, ramified, septate. In context and hymenium crystalline matter absent.

Setae rare or very rare, 55-75(-100) x (6-)-7-10(-12) μm , projecting to 50 μm above the hymenium, fusiform or subulate, with tip acute, straight, naked or enmeshed in hyphal sheaths, without incrustation.

Hook-like, curved or coiled hyphal tips absent or rare in specimens having basidia, but in sterile hymenium very numerous, to 2.5 μm diam, brownish, with slightly thickened walls, acute; hyphidia absent; basidioles present, without incrustation; basidia subclavate or (sub)utriform, with walls thickened and brownish at base, 12-30 x 4.5-5.5 μm ; sterigmata 4; spores cylindrical, slightly curved, 5.5-8.3 x 1.5-2.5 μm .

SUBSTRATA IN N. AMERICA. Found on more than 30 species of angiospermic trees and bushes, but of 143 specimens with data on the substrate, only 17 were on other hosts than oak. - *Acer* sp. (2), *Betula nigra* (1), *Carpinus caroliniana* (1), *Castanea dentata* (1), *Fagus* sp. (1), *Fraxinus velutina* (1), *Gordonia* sp. (2), *Juglans major* (1), *J. nigra* (1), *Ligustrum* sp. (1), *Populus* sp. (1), *Quercus alba* (26), *Q. coccinea* (3), *Q. garryana* (3), *Q. macrocarpa* (11), *Q. marilandica* (G & L, 1995), *Q. michauxii* (1), *Q. minor* (2), *Q. nigra* (G & L, 1995), *Q. obtusiloba* (2),

Q. palustris (1), *Q. platanoides* (1), *Quercus prinus* (1), *Q. rubra* (2), *Q. stellata* (9), *Q. toumeyi* (2), *Q. velutina* (3), *Q. virginiana* (6), *Quercus* sp. (53), ***Robinia*** *pseudacacia* (2), ***Sambucus*** *caerulea* (syn.: *S. glauca*) (1), ***Ulmus*** sp. (1).

DISTRIBUTION IN N. AMERICA. CANADA: MB (G & L, 1995). **MEXICO:** BS (Santa Catalina Is., 1). **USA:** AL (8), AR (8), AZ (7), CT (3), DC (4), DE (2), FL (16), GA (9), IA (5), IL (2), IN (2), KY (G & L, 1995), LA (16), MA (7), MD (16), MN (3), MO (21), MS (12), NC (14), ND (7), NH (1), NJ (12), NV (G & L, 1995), NY (6), OH (6), OK (2), OR (2), PA (7), SC (5), TN (7), TX (9), VA (22), WA (2), WI (9), WY (1).

DISTRIBUTION ELSEWHERE. Mesoamerica: Mexico, Panama, Puerto Rico.

TYPES STUDIED. *Stereum curtisii*: USA, South Carolina, H.W. Ravenel, Fungi Carol. III, 26 (NY, lectotype selected by Léger; BPI, isotype).

REMARKS. Crowded vertical hyphae with hooked or bent tips in hymenium are unique in *Hymenochaete* and enable to identify the species in sterile state. These hyphae are modifications homologous with hyphidia. When a specimen is with basidia, these hyphae are not numerous or even rare, and these specimens are very similar to *H. pinnatifida*. The last named species usually has numerous setae which are surrounded by a knot of agglutinated branched hyphae at base. **Misidentifications.** This species has been several times misidentified as *H. tabacina* or *H. corrugata*.

15. *Hymenochaete damicornis* (Link) Lév.

Figs. 4, 8; 6, 7

Lév., Ann. Sci. Nat. Bot. III 5: 151 (1846) ut *H. damaecornis*; Burt, Ann. Missouri Bot. Gard. 5: 306, pl. 16 f. 1 (1918); Léger, *Hymenochaete* 112, f. 31 (1998). - *Stereum damicorne* Link, Mag. Ges. Naturforsch. Freunde Berlin 3: 40 (1809); Lloyd, Mycol. Writ. 4, Stipit. *Stereum* 41, f. 564 (1913). - *Stipitochaete damicornis* (Link) Ryvarden, Trans. Brit. Mycol. Soc. 85 (3): 537, f. 1 (1985).

Basidiome stipitate; stem vertical or sometimes horizontal, usually with 2-5 short branches in the upper part, 2-10 cm high, 2-7(-10) mm diam, at the base (in section) round, more flattened towards the pilei, finely tomentose, covered with crowded setae, dark brown (M: 5 YR 5/6-8 to 4/6; K & W: 6 D-E 7, raw Sienna or cognac). Pilei flabelliform to spatulate, 300-700(-1200) μ m thick, 1-6 cm long; surface silky to velutinous, densely zonate, slightly radially sulcate, when young dark Sienna (M: 5 YR 6/8, K & W: 6 C 7, reddish golden), later Fulvous Umber (M: 5-7.5 YR 5/8; K & W: 6 D 6, cinnamon brown); margin thin, lobate, wavy, incised or lacinate, in young specimens lighter coloured than other pileal surface (M: 7.5 YR 8/8; K & W: 5 B 5). Hymenium smooth, azonate or with few zones near the margin, not cracked, cinnamon buff or greyish brown (M: 5 YR 5-6/4; K & W: 6 D-E 5, sunburn), without olive or lilac tint, covered with projecting setae.

Tomentum absent but scattered, thick- or thin-walled, or aborted setae present on upper surface; cortex absent; context thick, composed of parallel moderately densely arranged hyphae; setal layer in old specimens present, 100-200 μ m thick; dark line in the context or above the hymenium absent. Stipe composed of densely interwoven hyphae, but in well developed specimens differentiated into three layers: outer brown part up to 2 mm thick (tomentum) is composed of almost loosely interwoven hyphae, central yellowish cylinder

(core) of parallel hyphae with thin or thickened walls, and this is surrounded by a thin (100-150 μm) dark brown cortex of densely agglutinated thick-walled hyphae.

Hyphal system monomitic or subdimitic; setal hyphae absent; generative hyphae 2.5-6 μm diam, pale yellowish brown to rusty brown, with thin or thickened walls, septate, branched, in the core of the stipe pale golden yellow and 4-7 μm in diam, in the stipe tomentum with thickened walls, brownish, 3-5 μm diam.

Setae in hymenium rare, scattered or numerous, 90-160(-220) x 8-15 μm , projecting to 150 μm , aculeate to narrowly conical, naked or sheathed, straight, with acute tip, without incrustation; stipe covered with usually very numerous aculeate thick- or thin-walled setae up to 250 μm long; setae on pileal surface rare or scattered, 60-100 x 8-13 μm , sometimes abortive, thin-walled, cylindrical and with rounded tip, or short (40-50 x 8-10 μm).

Hyphidia and cystidia absent; basidioles in sterile hymenium numerous, subhyaline, with thin or thickened walls, 15-22 x 5-8 μm ; basidia subutriform or subclavate, 15-25 x 5-8 μm , with 4 thin sterigmata 4-5 μm long; spores broadly ellipsoid, with thin or slightly thickened walls, 5.5-8(-8.2) x 4-5.5 μm .

SUBSTRATA IN N. AMERICA. Unknown.

DISTRIBUTION IN N. AMERICA. MEXICO: OA (Montepío and NE of Matías Romero - Welden, Dávalos & Guzmán, 1979; Marmojelo, Castillo & Guzmán, 1979), VC (11).

DISTRIBUTION ELSEWHERE. Mesoamerica: Belize, Costa Rica, Guatemala, Honduras, Mexico (Chiapas), Panama, El Salvador; **Caribbean:** Cuba, Dominican Rep., Guadeloupe, Jamaica, Puerto Rico, Trinidad; **South America:** Argentina, Bolivia, Brazil, Colombia, French Guiana, Guyana, Paraguay, Peru, Suriname, Venezuela. - On rotten wood and roots of living deciduous woody plants and *Bambusa* sp. Common in Brazilian Amazonia.

TYPE STUDIED. Brazil, Sao Leopoldo, ad terram, Jan 1904 Rick, *Fungi Austro-Americani* no. 10 as *Hymenochaete formosa* Lév. (BPI, iso-lectotype).

REMARKS. Collected usually on ground but obviously parasitic on roots. The stipe is sometimes not clearly distinguished from pilei, and is then a prolonged narrow base of it. Sometimes the short stipe is horizontally branched. Structure of a thick, well developed stipe is surprisingly similar to that in *Clavariachaete* species: in both cases the central cylindric "core" of parallel hyphae is surrounded by a thin hard cortex and thick tomentum which bears strong setae. Differs from *Clavariachaete* in lacking dichotomously branched hyphae in the tomentum of *H. damicornis*.

H. damicornis is one of the few species of *Hymenochaete* which is almost always fertile; specimens with abundant spores have been collected in Mexico from July to November. Mean size and Q value of spores is:

6.18 x 4.68	1.32	(XAL, Samp 909)
6.37 x 4.77	1.33	(XAL, Band 281)
6.55 x 4.83	1.36	(XAL, Anell 527)
6.59 x 5.02	1.31	(XAL, Guzmán 30372)
6.71 x 4.92	1.36	(XAL, Samp 984)

7.05 x 4.78 1.47 (XAL, Gomez 11)
 7.68 x 4.72 1.63 (XAL, Chacon 2327)

16. Hymenochaete epichlora (Berk. & M.A. Curtis) Cooke Figs. 2, 6; 5, 4
 Cooke, Grevillea 8: 147 (1880); Burt, Ann. Missouri Bot. Gard. 5: 351, f. 20 (1918); Léger, Hymenochaete 130, f. 40 (1998). - *Corticium epichlorum* Berk. & M.A. Curtis, Grevillea 1 (12): 178 (1873). - *Hymenochaete asperata* Ell. & Everh., Bull. Torrey Bot. Club 27: 50 (1900).

Basidiome effused, 70-180(-230) μm thick, soft to coriaceous when dry, 5-10 x 1-3 cm, closely or loosely adnate. Hymenium smooth or somewhat granular, azonate, irregularly, soon densely cracked, greyish Cinnamon to dark Sienna (M: 5-7.5 YR 6-7/4 to 5/4, or 10 YR 5/6 (when young); K & W: 4 A 4, 6 C-D 5 or 6 E 5, light yellow, sunburn or cocoa brown), sometimes with an olive tint; margin thin, tomentose or indeterminate, sometimes slightly byssoid, Ochreous or concolorous with hymenium.

Tomentum absent, cortex absent or sometimes as a thin darker band of more tightly interwoven hyphae next to the substratum; context composed of hyphal layer; dark line above the hymenium absent; context hyphae rather densely interwoven.

Hyphal system monomitic or subdimitic (part of the hyphae hyaline, thin-walled, septate and more branching, others brownish and with thickened walls); setal hyphae absent; hyphae 2-4 μm diam, yellowish, thin-walled or with thickened walls, septate, branched; in context crystalline matter rarely present, in hymenium absent.

Setae rare or scattered, 30-60 x (4.5-)5.5-9 μm , projecting to 20(-35) μm , fusiform, with tip acute, straight or some slightly curved, some rarely T-shaped, naked, without incrustation.

Hyphidia and cystidia absent; basidioles present, with slightly thickened walls, without incrustation; basidia subclavate to (sub)utriform, 10-16 x 4-6 μm ; sterigmata 4, 3-4 μm long; spores ellipsoid, one side flattened, 3.5-5 x 1.8-2.5 μm .

SUBSTRATA IN N. AMERICA. *Ostrya virginiana* (1), *Quercus virginiana* (1), *Sabal palmetto* (1), *Symplocos* sp. (1), *Vitis* sp. (G & L, 1995).

DISTRIBUTION IN N. AMERICA. **MEXICO:** VC (Jalapa, 3). **USA:** AL (type of *C. epichlorum*), FL (Highlands Co, Highlands Hammock St. Pk., 29 Jan 1970 H.H. Burdsall 4835, CFMR; De Soto Co, Arcadia, 19 May 1985 J.P. Lindsey 1331, ARIZ), LA (type of *H. asperata*; St. Martinsville, 18 Mar. 31 Aug and 23 Nov 1899 A.B. Langlois 1751, 2089 and *s. n.*, NY, S; Tammany Par., Indian Village, 1 Feb 1958 D. Stone, det. A.L. Welden, NY and BPI 278119; St. James Par., near Gramercy, Sept 1961 A.L. Welden, det. F. Reeves, NY and BPI 278116), TX (San Jacinto Co, Little Thicket Nat. Sanctuary, 25 Aug 1967 H.H. Burdsall 77, CFMR).

DISTRIBUTION ELSEWHERE. **Southern America:** Argentina, Brazil; **Malaysia:** Java.

TYPES STUDIED. *Corticium epichlorum*: Alabama, on *Symplocos* sp., Peters; Ravenel, Fungi Carol. Exs. V, 24 (2 isotypes in BPI, 1 in S; lectotype not yet selected). *Hymenochaete asperata*: Louisiana, St. Martinville, 4 Jan 1898, no. 2647 (NY, holotype).

REMARKS. Similar to *H. cinnamomea*, but that is usually layered and with setae (60-)70-120(-150) x 5-9(-10) μm . *H. rigidula* is very similar when young and thin, but differs in presence of setal hyphae. **Misidentifications.** Some specimens collected by Langlois in 1890 and 1899 (BPI 278123, 278858-859, 278867, 278871) and identified by Burt (?) as *H. epichlora* are possibly *H. cervina*. A specimen of *H. asperata* from Burt's Herb. (on Fraxinus, Louisiana, coll. A.B. Langlois 21 Jan 1889, S) is *H. pinnatifida*.

Mean size and *Q* value of spores of *H. epichlora* are:

3.68 x 2.21	1.67	(FL, CFMR 4835)
3.92 x 2.30	1.71	(Mexico, NY, Murrill 338)
4.21 x 2.37	1.78	(TX, CFMR 77)

17. *Hymenochaete escobarii* Léger

Figs. 3, 4; 6, 10

Léger, Cryptogamie, Mycol. 11 (4): 296, f. 5 (1990); Léger, Hymenochaete 134, f. 42 (1998). - *H. dendroidea* Escobar nom. nud., Contr. Hymenochaete 92, f. 27 (1978) non Berk. & Broome (= *Hypomyces chrysostomus* Berk. & Broome 1875, Hypocreales).

Basidiome with well developed pilei, sometimes seemingly resupinate but really umbonate-adnate (with free, slightly elevated marginal part), woody hard and brittle when dry, (150-)300-1500(-2500) μm thick. Pilei single or confluent, imbricate, semicircular, 0.5-2.5 cm long; pileal surface deeply concentrically sulcate, rugose or tomentose, Umber, later dark Umber or blackish (M: 5 YR 4/6 or 4/4; K & W: 7 E 5); margin thin. Hymenium smooth or with scattered rounded collicles, not cracked or with a few deep crevices, Cinnamon to Fawn, bright Fulvous or dark Sienna (M: 5 YR 5-6/4, 5-6/8 or 5/6; K & W: 7 D 4, sometimes 5 D 8, 5 C 7 or 6 D 7), without olive or without a lilac tint. Setal layer under looking glass distinctly stratose (with some or numerous dark lines).

Tomentum and cortex present, later indistinct; context composed of hyphal layer and a stratose setal layer; dark line above the hymenium absent.

Tomentum (30-)50-300 μm thick, hyphae loosely interwoven; in old specimens disappearing; cortex 25-80 μm thick, hyphae parallel densely agglutinated, rust brown; hyphal layer 100-1300 μm thick, hyphae more or less compactly longitudinally arranged.

Hyphal system subdimitic; setal hyphae absent; generative hyphae yellowish, thin-walled, 2-4 μm in diam; skeletoids brownish or brown, thick-walled, 3-5 μm in diam; in context, setal stratum and hymenium crystalline matter locally present.

Setal layer 100-1000 μm thick, 3-15 stratose, each composed of old thick-walled, later agglutinated brownish dendrohyphidia, vertically arranged hyphae and setae; between strata thin (20-30 μm) layer of densely interwoven brown hyphae; setae rare or not numerous, (25-)35-80(-100) x (4-)5-8(-9) μm , projecting 20-40 μm , subulate, with acute tip, straight, naked or enmeshed in hyphal sheaths, without incrustation.

Dendrohyphidia in sterile hymenial layer numerous, hyaline or yellowish, in upper half repeatedly branched (tree-like), up to 45 μm long, 1.5-3.5 μm in diam; in fertile (basidia-bearing) hymenium less numerous or very rare, with

thick brown walls, agglutinated with brown resinous matter; no cystidia; basidioles present, 15-18 x 3.5-5 μm , without incrustation; basidia clavate or almost cylindrical, hyaline or at base with thickened brownish walls, 20-30 x 5.5-7 μm ; sterigmata 4, 4-5 μm long; spores broadly ellipsoid, with one side slightly flattened, sometimes with a guttula, (5-)5.2-6.5(-7) x (3-)3.5-4.5(-4.8) μm .

SUBSTRATA IN N. AMERICA. *Cerocarpus* sp. (1), *Prosopis glandulosa* (2).

DISTRIBUTION IN N. AMERICA. **USA:** AZ (Pima Co, Coronado Nat. Forest, Lower Bear Canyon and Sabino Canyon, 16 Nov 1972 R.L. Gilbertson 1274, 1277, 5700; Carr Canyon, 3 Oct 1975 R.L. Gilbertson 11418, ARIZ).

DISTRIBUTION ELSEWHERE. **Mesoamerica.** Costa Rica (Las Tablas Protector Zone, 24 Jun 1999 K. Haugerud 121, O and TAA; Rio Grande, Luquillo Mts., 18 Jun 1996 K.H. Larsson 9024, G and TAA); Panama, Canal Zone, Chiriqui, 17-19 Mar 1911 W.R. Maxon 559 (BPI). **Caribbean.** Dominica (Basin Will [= ?], 19 Aug 1992 M.R. Elliotte 356, K); Puerto Rico (30 Apr 1991 Setliff & L. Sevean 1860, K; P. Roberts 542, K). **Northern South America.** Venezuela (type).

TYPE STUDIED. Venezuela, Estado Bolívar, Torono-Tepuí, Chimantá Massif, 23 Feb 1955 J.A. Steyermark & J.J. Wurdack 1115 (NY, holotype).

REMARKS. Seemingly effused specimens are sometimes very similar to *H. pinnatifida*; that species differs with closely adnate truly resupinate basidiomata and cylindrical, slightly curved spores 4-6(-7) x 1.5-2.5(-2.8) μm .

The holotype of *H. escobarii* is sterile; Costa Rican specimen *Haugerud 121* has some heavily damaged spores, but three Arizona collections have numerous, partly undamaged spores. Unique combination of characters (pileate basidiomata with tomentum, cortex, hyphal and stratoose setal layer; presence of well developed dendrohyphidia) and size of setae, colour of hymenium makes it possible to assert conspecificity of these collections. Mean size of spores was 5.85 x 3.84, 6.03 x 3.95 and 6.38 x 4.12 μm in the Arizona specimens; mean *Q* value was 1.52, 1.53 and 1.55. Dendrohyphidia are very distinct in sterile specimens but agglutinated with brown resinous matter and indistinct in sporulating ones.

18. *Hymenochaete fuliginosa* (Pers.) Lév.

Figs. 4, 4; 6, 4

Lév., Ann. Sci. Nat. III 5: 152 (1846); Léger, *Hymenochaete* 145, f. 48 (1998) p. p. - *Thelephora fuliginosa* Pers. Mycol. Eur. 1: 145 (1822). - Not *H. fuliginosa* sensu Berk., 1869, Wakef., 1915 and Burt, 1918.

Basidiome effused, closely adnate, hard when dry, (50-)75-400(-600) μm thick but usually only up to 300 μm , 0.2-1 cm in diam, then confluent and up to 10 cm long. Hymenium smooth or slightly uneven, later densely irregularly cracked, dark Umber or dark chocolate (7.5 YR 4/4; K & W: 7 E 4-5, fawn to Somalis), without olive or lilac tint; margin thin, abrupt, when young rust brown and tomentose, then concolorous with hymenium or with a darker zone.

Tomentum absent, cortex absent or indistinct; context composed of setal layer of overlapping rows of setae, sometimes thin indistinct hyphal layer present; dark line above the hymenium absent.

Cortex 5-25 μm thick when present; hyphae densely interwoven, indistinct, agglutinated, brown; hyphal layer when present up to 30 μm thick, hyphae compact, longitudinally agglutinated.

Hyphal system monomitic; setal hyphae absent; generative hyphae 2-4 μm in diam, yellowish to brownish, thin-walled or with thickened walls, agglutinated, subindistinct; in context and hymenium crystalline matter absent.

Setal layer 50-575 μm thick; setae numerous, (60-)65-100 x (6-)7-11 μm , partly projecting up to 65 μm , subulate, with acute or very sharp tip, straight, naked, without incrustation.

Hyphidia not numerous to numerous, hyaline or yellowish, 2.5-3 μm in diam, thin-walled, without incrustation; cystidia absent; basidioles absent or present, 2.5-3.5 μm in diam, without incrustation; basidia clavate or subclavate, 13-18 x (3.5-)4-5 μm ; sterigmata 4, about 4 μm long; spores cylindrical, slightly curved, 5-6.5(-7) x 1.8-2.6(-2.8) μm .

CULTURAL CHARACTERS. Léger & Lanquetin, 1996: 108.

SUBSTRATA IN N. AMERICA. On wood and bark of coniferous trees, except in Alaska also on birch and in Arizona on poplar. - *Abies grandis* (3), *A. lasiocarpa* var. *arizonica* (1), *Betula* sp. (1), *Chamaecyparis thyoides* (1), *Juniperus virginiana* (2), *Larix occidentalis* (3), *Libocedrus decurrens* (1), *Picea engelmannii* (1), *P. glauca* (5), *P. x lutzii* (2), *P. mariana* (1), *Picea* sp. (6), *Pinus albicaulis* (1), *P. contorta* (4), *P. resinosa* (2), *Pinus* sp. (2), *Populus* spp. (1), *Pseudotsuga macrocarpa* (1), *P. menziesii* (5), *Thuja occidentalis* (14), *T. plicata* (3), *Tsuga canadensis* (1), *T. heterophylla* (4), *Tsuga* sp. (3).

DISTRIBUTION IN N. AMERICA. CANADA: AB (2), BC (3), ON (2). **USA:** AK (10), AZ (4), CA (2), CO (8), ID (8), MD (1), MI (16), MT (12), NC (1), NY (2), PA (1), TN (2), WA (1).

DISTRIBUTION ELSEWHERE. Europe: Austria, Byelorussia, Czechia, Estonia, Finland, France, Germany, Norway, Poland, Russia (Komi and Murmansk Reg., Ural), Slovakia, Sweden, Ukraine (Transcarpatia); **Asia-Temperate:** Caucasus, China, Japan, Russian Far East (incl. Kamchatka and Sakhalin Is.), Siberia, Turkmenistan. - On logs and trunks of coniferous trees; found once also on *Salix* sp. in N. Sweden and in Norway.

TYPE. Possibly lost; an unpublished and ill-considered neotype (USA, Ohio, Burt 33121, BPI) designated by DeFigio (1970: 62) belongs to *H. jobii*, not to *H. fuliginosa*.

REMARKS. A thin layer of parallel agglutinated hyphae 15-30 μm thick may be present at base of the basidioma; this may be called cortex, or hyphal layer equally. Some American authors (Jung, 1987: 136; DeFigio, 1970: 62) have not distinguished *H. fuliginosa* and European *H. subfuliginosa* Bourdot & Galzin; Léger (1998: 145) considered these names to be synonymous. Closely related *H. jobii* differs in its spores (ellipsoid, 4.5-6 x 2.3-3 μm) and substrate (angiospermic trees, mainly oak). *H. fuliginosa* is also similar to *H. corrugata* which differs in more slender spores 4.5-6.8 x 1.5-2.3 μm and setae always encrusted in upper part with amorphous granules, or with a rugose tip.

H. fuliginosa has been described from N. America and Cuba as growing on wood of deciduous trees by Burt, 1918: 365 (on wood of *Betula*, *Rhododendron*), or as growing on *Betula* by Jung (1987: 136), but spores of the American specimens have been described as 4 x 2 μm (Burt) or 5-6.5 x 3-4

μm , broadly suballantoid to ovoid (DeFigio, 1970). The Cuban specimen (MO 55156, BPI) mentioned by Burt (1918) was studied by Reeves & Welden (1967: 1044); its spores were described by them as $5 \times 3 \mu\text{m}$, ovoid. Possibly most of the specimens mentioned by these authors belong to *H. jobii*. *H. fuliginosa* has been found on angiospermic trees as an exception in northern regions (Alaska, Norway, Sweden) where this species is common. **Misidentifications.** Several specimens filed under the name *H. fuliginosa* in herbaria are misidentified; these belong to *H. jobii*, others to *H. cinnamomea* ssp. *spreti*, *H. corrugata*, *H. curtisii*, *H. pinnatifida*, *H. semistupposa*. On the other hand, several specimens of *H. fuliginosa* have been filed under the name *H. tenuis*.

19. *Hymenochaete fulva* Burt

Figs. 4, 1; 5, 12

Burt, Ann. Missouri Bot. Gard. 5: 354, f. 23 (excl. 23-c) (1918); Reeves & Welden, Mycologia 59 (6): 1044 (1967); Léger, Hymenochaete 149, f. 49 (1998). - Not *H. fulva* sensu Doidge, Bothalia 5: 484 (1950): see Talbot, Bothalia 7: 155 (1958).

Basidiomata effused, closely adnate, coriaceous when dry, 1-1.5 cm in diam, then confluent and up to 8 cm long, 100-225 μm thick. Hymenium smooth, not cracked or with few deep crevices, Cinnamon (light) brown (M: 7.5 - 10 YR 5-6/5-6; K & W: 5-6 D 6, cinnamon brown or oak brown), without olive or lilac tint; margin abrupt, distinctly limited, yellowish Ochraceous (M: 7.5-10 YR 8/6-7; K & W: 5 B 5, dull apricot yellow).

Tomentum absent, cortex present; context composed of hyphal layer composed of loosely interwoven hyphae; dark line above the hymenium usually present.

Cortex 12-30 μm thick, hyphae tightly interwoven, thick-walled, 2.5-4 μm .

Hyphal layer 40-50 μm thick.; hyphal system monomitic; setal hyphae in hyphal layer absent; generative hyphae with thickened walls, brownish, branched, septate, 2.5-4 μm in diam, some encrusted with resinous matter; in hymenium crystalline matter present, sometimes forming agglomerates up to 20 μm in diam.

Setae in hymenium numerous, (60-)70-90(-95) $\times$ (6-)7-9(-10.5) μm , projecting up to 60 μm , subulate to subfusiform, straight, without or with a hyphal sheath, without incrustation, tips acute.

Hyphidia absent; heavily encrusted cystidia-like hyphal ends with a conglomerate of crystals 20-30 $\times$ 6-10 μm sometimes present; basidioles present; basidia clavate, hyaline, 18-25(-30) $\times$ 5-6 μm ; sterigmata 4, 3-4 μm long; spores broadly ellipsoid, (4.8-)5-6(-6.2) $\times$ 3.2-4 μm .

SUBSTRATA IN N. AMERICA. Unknown.

DISTRIBUTION IN N. AMERICA. MEXICO: VC (Botanical Garden, near Xalapa, 1300 m, 6 Jan 1992 M. Palacios-Ríos 3453, XAL; TAA 174363). - The collection from USA, Louisiana mentioned in the original description of the species by Burt (1918: 335) is a mixture of *H. pinnatifida* and *H. episphaeria* according to DeFigio (1970: 66).

DISTRIBUTION ELSEWHERE. Caribbean: Jamaica (holotype). Mentioned by Doidge (1950) from Southern Africa, possibly erroneously.

TYPE STUDIED. Jamaica, Cinchona, W.A. & E.L. Murrill 645 (NY; the basidiome, less than 1 cm in size, was not studied microscopically).

REMARKS. Externally similar and possibly related to *H. cinnamomea* which differs in lack of cortex and spores $4.5\text{--}6.5\text{--}(7) \times 1.8\text{--}2.8\text{--}(3) \mu\text{m}$. Cystidia of *H. fulva* described and figured by Burt (1918) and Léger (1998) are actually encrusted tips of hyphae, only slightly differentiated and of little use in identification of this species. Spore size of the holotype was described as $4\text{--}5.5 \times 3\text{--}4 \mu\text{m}$ by Léger (1998: 149), $6 \times 3\text{--}3.5 \mu\text{m}$ by Reeves & Welden (1967: 1045) and $5\text{--}6.2 \times 3\text{--}4 \mu\text{m}$ by D.J. Job (note with the type in NY). Mean spore size of the Mexican specimen is $5.44 \times 3.63 \mu\text{m}$; $Q = 1.50$.

20. *Hymenochaete jobii* Parmasto

Figs. 3, 9; 5, 10

Parmasto, Folia Cryptog. Estonica 37: 62, f. 1, 5 (2001). - *H. corticolor* sensu Reeves & Welden, Mycologia 59 (6): 1043 (1967) and Job, Mycol. Helvet. 4 (1): 16 (1990). - *H. unguolata* Burt, Ann. Missouri Bot. Gard. 5: 338 (1918).

Basidiomata effused, closely adnate, hard when dry, 0.5–1.5 cm in length, then confluent and up to 15 cm, (150–)300–1000(–3000) μm thick. Hymenium usually with scattered or densely situated low rounded tubercles, azonate, not cracked or with not numerous irregular cracks, greyish brown (M: 5 YR 5/4; K & W: 6 D 3–4, camel or café-au-lait), later brown or dark chocolate brown (M: 7.5 YR 4/4–7; K & W: 6 F 7 – 6 E 3, chestnut brown to greyish brown), without olive or lilac tint; margin fibrillose when young, 0.5–1 mm broad, whitish or yellowish brown (M: 7.5 YR 5/8–10; K & W: 6 D 7), then disappearing, concolorous with hymenium or more clearly brown (without a grey tint).

Tomentum absent; cortex absent but when basidiome young, a thin (10–50 μm) basal layer of parallel densely packed hyphae present; context composed of setal layer as overlapping or distinct rows of setae; dark line above the hymenium present or absent.

Cortex (when present) hyphae interwoven, brown, agglutinated; context hyphae compactly arranged, erect.

Hyphal system monomitic with indistinct differentiation to generative and pseudoskeletal hyphae; setal hyphae absent; generative hyphae 2–4.5 μm in diam, yellowish to brownish, with thickened walls, ramified, usually distinct; in context of old specimens agglomerates of crystalline matter.

Setal layer 200–3000 μm thick; setae numerous, (50–)60–110(–120) $\times$ 7–12(–15) μm , projecting up to 60 μm , subulate, with acute tip, straight or some with slightly curved tip, naked or with a hyphal sheath, without incrustation or sometimes encrusted with small crystals at tip.

Cystidia absent; hyphidia not numerous to numerous, hyaline or yellowish, 2–3 μm in diam, thin-walled, without incrustation, but rarely with slightly thickened and granulose walls; basidia clavate or subclavate, 15–25 $\times$ 3.5–5 μm ; sterigmata 4, 3–5 μm long; spores ellipsoid, with one side flattened, 4.5–6 $\times$ 2.2–3.2(–3.5) μm .

Causes a white pocket rot of wood.

SUBSTRATA IN N. AMERICA. *Acer* sp. (7), *Alnus oblongifolia* (1), *Betula* sp. (1), *Castanea* sp. (1), *Fagus grandifolia* (2), *Fagus* sp. (3), *Juglans major* (2),

Populus tremuloides (1), **Populus** sp. (1), **Quercus arizonica** (1), **Q. hypoleucoides** (3), **Q. reticulata** (1), **Q. rubra** (syn.: **Q. borealis**) (4), **Quercus** sp. (15).

DISTRIBUTION IN N. AMERICA. CANADA: ON (5), PQ (1). **USA:** AZ (10), CT (1), KY (1), LA (1), MD (1), ME (1), MI (16), NC (9), NY (4), OH (1), PA (1), TN (2), VA (2), VT (4), WI (4).

DISTRIBUTION ELSEWHERE. Caribbean: Cuba, Jamaica; **South America:** Brazil, Ecuador.

TYPES STUDIED. *H. jobii*: USA, New York, Schuyler Co, Van Etten, Arnot Forest, on *Betula* sp., 19 Sep 1970 H.H. Burdsall 4932 (TAA 171182, holotype; CFMR, BPI, isotypes). *H. unguolata*: Mexico, Jalapa, 12-20 Dec 1909 W.A. & E.L. Merrill 176 (NY, holotype; BPI 348551, isotype).

REMARKS. The name *H. corticolor* Berk. & Ravenel has been misused for this species in many cases; unfortunately, the type of the first belongs to *H. cervina*. Both species as well as *H. unicolor* are closely related sibling species; the differences are described under *H. cervina*. Macroscopically the very similar *H. fuliginosa* differs in cylindrical slightly curved spores 5-6.5(-7) x 1.8-2.6(-2.8) μm , broader setae and growing on conifers. Resupinate basidiomata of *H. rubiginosa* also grow on oak wood and are sometimes quite similar to *H. jobii*, but differ in free margins of easily separable from substratum basidiomata, by presence of tomental and basal hyphal layers and spores (3.5-)3.8-5.5 x (1.8-)2-2.8(-3) μm .

In Europe, a possibly very closely related species *H. subfuliginosa* Bourdot & Galzin has been found growing on wood of *Quercus* spp.

The basidiomata of *H. jobii* are usually resupinate but sometimes with thickened, somewhat reflexed black upper margin (e. g., specimens from Nova Scotia, L.E. Wehmeyer 628, NY and Florida, N.L.T. Nelson, BPI 329792). *H. unguolata* Burt is possibly based on such an old and weathered specimen. The type of that species is sterile; whitish gray colour of its hymenial surface is caused by numerous crystals and agglutinated hyphae; setae are sheathed with hyphae, 60-95 x 9-12 μm , with indistinct contours; it is possible that the sterile when collected specimen has been preserved in alcohol. Lindblad & Ryvarden (1999) described a specimen under the name *H. unguolata* from Costa Rica, but it has small setae 30-50 x 6-8 μm and spores 4-5.2 x 2.3-2.8(-3) μm , both typical for *H. unicolor*.

Many of the specimens mentioned in literature as *H. fuliginosa* or *H. fusca* (P. Karst.) Sacc. collected on wood of deciduous trees and having ellipsoid or ovoid spores may belong to *H. jobii*. **Misidentifications.** *H. jobii* has sometimes been filed in herbaria under the names *H. corrugata* and *H. rubiginosa*.

21. *Hymenochaete leonina* Berk. & M.A. Curtis Figs. 2, 12; 5, 11

Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10 (46): 334 (1868); Burt, Ann. Missouri Bot. Gard. 5: 353, f. 22 (1918); Reaves & Welden, Mycologia 59 (6): 1045 (1977); DeFigio, Tax. anal. 44, f. 15, pl. 4 f. 15a (1970); Léger, Hymenochaete : 174, f. 62 (1998).

Basidiomata effused, adnate but separable when moist or as pieces when dry, soft coriaceous when dry, 100-800 μm thick, 0.5-2 cm in diam, when con-

fluent up to 10 cm in extent. Hymenium smooth, azonate, not cracked, Isabelous Cinnamon, darker in center (Sienna to Umber or cocoa brown) (M: when young 7.5 YR 6/8, then 5-7.5 YR 4-5/6-7 to 6/10; K & W: 6 D-E 4 - 6 E 7, camel to cognac), sometimes with an olivaceous tint; margin thin, up to 2 mm wide, abrupt, sometimes tomentose or indeterminate, lighter coloured than hymenium, Fulvous (M: 7.5 YR 7/8-10; K & W 5 B 6, apricot yellow) or concolorous.

Tomentum absent or present as the upper part of the hyphal layer; cortex present as a dark line up to 55 μm thick in the middle of the seemingly duplex hyphal layer dividing it into two parts of more or less the same thickness; context composed of hyphal layer and a setal layer; upper and lower part of the hyphal layer similar in texture; setal layer present as overlapping or indistinct rows of setae; dark line above the hymenium present or absent.

Hyphal layer 100-700 μm thick; hyphae loosely interwoven, in the lower part somewhat descending; hyphal system monomitic; setal hyphae absent; generative hyphae 2.5-4 μm in diam, yellowish or brownish, with thickened walls or thick-walled, septate, rarely branched; in context, setal stratum and hymenium crystalline matter absent.

Setal layer 50-250 μm thick, darker than hyphal layer; setae numerous, in 1-4 indistinct rows, 40-80(-90) $\times$ (6-)-7-13(-14) μm , projecting up to 30-60 μm , conical to slightly fusiform, with almost blunt or acute tip, straight or some with slightly curved tip, enmeshed in hyphal sheaths or naked, without incrustation; in marginal part of the basidiome sometimes embedded curved setae up to 120 μm long.

Hyphidia in fertile hymenium absent, in sterile hymenium numerous (sometimes rare), yellowish, cylindrical or slightly conical, with almost blunt conical tip, 2-3 μm in diam, with thickened walls, without incrustation; basidioles present, without incrustation; basidia clavate or subclavate, 14-20(-25) $\times$ 4-6 μm ; sterigmata 4, 4-5 μm long; spores short-cylindrical, slightly curved, or ellipsoidal with one side slightly flattened, 3.8-5.5 $\times$ (1.8-)2-3(-3.2) μm .

SUBSTRATA IN N. AMERICA. *Fraxinus velutina* (G & L, 1995), *Juglans major* (1), *Liquidambar styraciflua* (2), *Quercus arizonica* (G & L, 1995), *Rhizophora* sp. (1).

DISTRIBUTION IN N. AMERICA. MEXICO: OA (San Pedro Yoloxtlan (Escobar, 1978), SI (San Blas, 12 Jun 1970 C.K. Sylber 322, BPI 277515), VC (Lanborn, C.R. Orcutt 1920, NY, K). **USA:** AR (Burt, 1918: 354), AZ (Santa Cruz Co, Coronado Nat. Forest, 12 Aug 1971 H.H. Burdsall 6006, 6008, CFMR), KY (DeFigio, 1970: 46, but the cited specimen not found in BPI), LA (St. Martin Parish, N of Chacaboula, 14 Oct 1956 A.L. Welden 1028, NY; near St. Martinsville, 4 Aug 1889 A.B. Langlois 2091, BPI and NY, and Nov 1899 A.B. Langlois, K), NC (Haywood Co, Baxter Creek Trail, 6 Jul 1970 H.H. Burdsall 4207, CFMR).

DISTRIBUTION ELSEWHERE. **Caribbean:** Cuba, Jamaica, Guadeloupe, Trinidad; **South America:** Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Uruguay, Venezuela; **East Tropical Africa:** Kenya; **Southern Africa:** India, Sri Lanka. Mentioned also from Great Britain but these

data are doubtful. - On angiospermic trees (*Aspidosperma* sp., *Nectandra* sp. et al.); most collections are from unknown substrata.

TYPE STUDIED. Cuba, C. Wright 532 (K, holotype; "Cuba Orientalis, 1856-7 C. Wright 423", FH 3027, isotype ?).

REMARKS. Easily distinguishable by soft loose subiculum and a dark line in the middle of context ("hyphal layer"); however, it is sometimes lacking, especially in young specimens; sometimes there are 2-4 lines. This line is homologous with cortex, and there is no duplex hyphal layer in this species: the upper part of the context is tomentum, not an "upper" part of the hyphal layer. **Misidentifications.** In some cases *H. corrugata*, *H. pinnatifida* and *H. tabacina* have been misidentified as this species.

Mean spore size and *Q* value of the specimens studied:

4.08 x 2.31	1.77	(NC, CFMR 4207)
4.28 x 2.53	1.69	(AZ, ARIZ 6008)
4.38 x 2.31	1.89	(CFMR 3927)
4.53 x 2.34	1.94	(Jamaica, K, Roberts GA627)
4.57 x 2.84	1.61	(AZ, CFMR 6006)

22. *Hymenochaete luteobadia* (Fr.) Höhn. & Litsch. Figs. 2, 5; 6, 1

Höhn. & Litsch., Sitzungsber. K. Akad. Wiss. Wien, Math.-nat. Kl. I 116: 750 (1907); Burt, Ann. Missouri Bot. Gard. 5: 323, f. 8 (1918); Reeves & Welden, Mycologia 59 (6): 1045, f. 1 B (1967); DeFigio, Tax. anal. 48, f. 17, pl. 5 f. 17a (1970); Léger, *Hymenochaete* 184, f. 67 (1998). - *Thelephora luteobadia* Fr., Linnaea 5: 526 (1830). - *Stereum laetum* Berk., J. Acad. Nat. Sci. Philadelphia 2: 279 (1853). - *Stereum pulchrum* (Schwein. ex Cooke) Cooke in Sacc., Syll. fung. 6: 561 (1888). - *Hymenochaete reflexa* Burt, Ann. Missouri Bot. Gard. 5: 336, f. 12 (1918). - *Hymenochaete cubensis* Burt, Ann. Missouri Bot. Gard. 5: 327, f. 13 (1918).

Basidiome effuso-reflexed or sessile-pileate, coriaceous when dry, 185-700(-1000) μ m thick. Pilei single or a few growing together to confluent, imbricate, flabelliform to dimidiate, 0.2-3 cm long, up to 6(-8) cm broad, somewhat flexible or brittle when dry; pileal surface concentrically sulcate and zonate, velutinous or tomentose to strigose with glabrous zones, becoming glabrous or radially fibrillose when old, reddish brown or brown (M: 5-5 YR 5/7 or 4.5/6 or 2.5 YR 4-5/6; K & W: 6 D 6 - 6 F 6, 5 B 2 - 5 B 3, cinnamon brown to burnt umber, rarely with orange grey to brownish grey concentric bands); margin thin, entire or lobate, ruffled, concolorous with the pileal surface or lighter coloured (yellowish brown). Hymenium smooth, azonate or faintly zonate, not cracked, greyish orange to pale reddish brown or dark fulvous; rusty brown in old specimens (M: 7.5 - 10 YR 6-6.5/4-6 or 7.5 YR 6/6 - 5/8; K & W: 5 B 3 - 5 B 6 to 5 C 4 - 5 C 6, greyish orange to brownish orange), sometimes with an olive tint; margin concolorous with hymenium or lighter coloured (when young: whitish orange).

Tomentum present or almost indistinct (as abhymenial hairs); cortex present; context composed of hyphal layer or hyphal and setal layer of overlapping rows of setae; dark line above the hymenium absent.

Tomentum 50-400 μ m thick, consists of loose spongy tissue of more or less erect and somewhat entwined hyphae with brownish thickened walls,

septate, 2.2-3.3 μm in diam; cortex 20-65 μm thick, its hyphae densely parallel or interwoven; hyphal layer 200-500 μm thick, hyphae compactly longitudinally arranged.

Hyphal system monomitic; setal hyphae absent; generative hyphae 2.5-3.5 μm in diam, brownish or brown, with thickened walls or thick-walled; in context, setal stratum and hymenium crystalline matter absent.

Setal layer (when present) 80-400 μm thick; setae not numerous, (25-)40-60 x 5-8 μm , projecting to 35 μm , distinctly fusiform, with acute tip, straight or some slightly curved or falcate, enmeshed in hyphal sheaths, without incrustation.

Hyphidia usually numerous, brownish, slightly conical, 2-3 μm in diam, with (sometimes unevenly) thickened walls to thick-walled, without incrustation or in upper part with small brown granules which may dissolve in KOH solution; cystidia absent; basidioles present, without incrustation; basidia clavate or subclavate, 15-20 x 4-5 μm ; sterigmata 4, 4-5 μm long; spores oblong-ellipsoid, one side flattened, 4-5(-5.5) x 1.8-2.5 μm .

CULTURAL CHARACTERS. Boidin & Lanquetin, 1984: 214; Job, 1986: 228.

SUBSTRATE IN N. AMERICA. Unknown.

DISTRIBUTION IN N. AMERICA. MEXICO: VC (Uxpanapa reg., Cam-pamento Hermanos Cedillo, 14 Jul 1976 A.L. Welden 3677, XAL).

DISTRIBUTION ELSEWHERE. Mesoamerica: Mexico (Campeche and Yuka-tan), Belize, Costa Rica, Panama; **Caribbean:** Cuba, Dominica, Jamaica, Grenada, Guadeloupe, Puerto Rico, Santa Lucia, Trinidad; **South America:** common - Argen-tina, Bolivia, Brazil, Colombia, Galápagos, Guyana, Paraguay, Peru, Suriname, Venezuela; **Africa:** Angola, Burundi, Central African Republic, Ethiopia, Kenya, Madagascar, Rwanda, South African Republic, Tanzania, Uganda, Zaire, South Africa; **Asia-Temperate:** China; **Asia Tropical:** India, Malaysia (Sabah), Nepal, Philippines, Thailand, Vietnam; **Australasia:** Australia, Tasmania. - On rotten wood of angiosper-mic trees; host of most collections unknown (some few hosts mentioned, e. g., *Acacia arabica*).

TYPES STUDIED. *H. cubensis*: Cuba, Alto Cedro, March 1903 L.M. Under-wood & F.S. Earle 1491 (NY); *H. reflexa*: Jamaica, 12-14 Jan 1909 W.A. Murrill & W. Harris 989 (NY).

REMARKS. Characteristic for *H. luteobadia* are relatively small distinctly fusiform setae, presence of numerous brownish encrusted hyphidia with thick-ened walls, presence of tomentum and cortex, and dull grayish-yellowish or ochraceous colour of hymenium. Most of the specimens of this species studied by me are sterile; in one collection from Mexico (Yucatan, Quintana Roo, Guz-mán 20791, XAL) the mean spore size is 4.56 x 2.26 μm ; $Q = 2.02$.

23. *Hymenochaete pinnatifida* Burt

Figs. 2, 9; 5, 19

Burt, Ann. Missouri Bot. Gard. 5: 355, f. 24 (1918); DeFigio, Tax. anal. 23, f. 5, pl. 2 f. 5a (1970); Léger, *Hymenochaete* 218, f. 83-84 (1998).

Basidiomata effused, adnate, sometimes with separable margins, coria-ceous when dry, growing as small patches 0.5-1.5 cm in diam, then confluent and up to 10 cm in length, 100-350 μm thick. Hymenium smooth or with scat-tered low tubercles, azonate, when old irregularly cracked, greyish brown or

light brown (M: 7.5-5 YR 6/2 to 5/4; K & W: 6 D 2-4), then cocoa brown, chestnut brown or dark brown (M: 7.5 YR 4/6-7, 4-5/4 or 6/6; K & W: 6 E-F 5-7, teak brown to dark brown); margin finely fibrillose, 0.5-1 mm broad, whitish or light brownish orange (M: 5 YR 5/6 to 7.5 YR 6/8; K & W: 6 C-D 5-6 or 6 D 4), later concolorous with hymenium or brown without a grey tint.

Tomentum absent; cortex present; basidiome composed of hyphal and one setal layer, rarely 2-3 alternating hyphal and setal layers present; dark line above the hymenium present, about 12-32 μm thick, composed of thick-walled agglutinated hyphae 2-3 μm in diam.

Cortex 15-25 μm thick, hyphae parallel or interwoven, dark reddish brown, thick-walled, agglutinated, 2-2.5(-3) μm in diam.

Hyphal layer 40-300 μm thick, hyphae loosely longitudinally arranged or interwoven; hyphal system subdimitic; setal hyphae absent; generative hyphae 1.8-2.7 μm in diam, hyaline or subhyaline, thin-walled, septate, ramified; skeletoids numerous, yellowish brown, 2.3-3.8 μm in diam, thick-walled; setal stratum and hymenium contain crystalline masses 10 - 20 x 10 μm .

Setal layer 30-100(-250) μm thick, with a few or up to 10 overlapping rows of setae; setae of two types: numerous setae 15-40 x 3-6 μm , embedded; not numerous big setae 40-70 x 5-8(-10) μm , projecting to 40 μm , both conical-fusiform, with acute tip, straight, naked or enmeshed in hyphal sheaths, without incrustation.

Simple hyphidia absent or present, 2-3 μm in diam, walls brownish, thickened; dendrohyphidia with thickened brownish walls, stem 12-22 x 2-3(-6) μm , in upper half or uppermost part repeatedly branched, with pinnatifid tips; cystidia absent; basidioles present, without incrustation; basidia not numerous, clavate or subclavate, 14-18 x 3-4.5 μm ; sterigmata 4, about 3.5-4 μm long; spores cylindrical, slightly curved, 4-6(-7) x 1.5-2.5(-2.8) μm .

CULTURAL CHARACTERS. Job, 1986: 223; Léger & Lanquetin, 1989: 328 and 1996: 115.

SUBSTRATA IN N. AMERICA. *Abies fraseri* (1), *Acer negundo* (1), *A. rubrum* (1), *Alnus rugosa* (G & L, 1995), *Alnus* sp. (1), *Betula populifolia* (1), *Carya* sp. (3), *Celtis laevigata* (1), *Elaeagnus umbellata* (G & L, 1995), *Fagus* sp. (3), *Fraxinus velutinus* (2), *Fraxinus* sp. (1), *Gordonia lasianthus* (1), *Ilex vomitoria* (1), *Juglans major* (1), *Juniperus deppeana* (1), *Liquidambar styraciflua* (2), *Magnolia virginiana* (1), *Magnolia* sp. (1), *Micropholis guyanensis* (syn.: *M. chrysophylloides*) (1), *Myrica cerifera* (1), *Parthenocissus* sp. (1), *Persea* sp. (1), *Prunus* sp. (2), *Quercus falcata* (1), *Q. nigra* (1), *Q. prinus* (1), *Quercus* sp. (12), *Sabal palmetto* (1), *Salix* sp. (2), *Taxodium* sp. (1), *Ulmus* sp. (1).

DISTRIBUTION IN N. AMERICA. MEXICO: NL (Escobar, 1978), VC (1). **USA:** Rather rare, mainly found in the southern part of the USA. AK (1), AL (2), AR (1), AZ (3), CA (2), FL (47), GA (5), IL (3), LA (12), MA (1), MD (1), MS (14), NC (2), NM (1), NY (3), OH (2), PA (5), SC (1), TX (2), VA (2), VT (1).

DISTRIBUTION ELSEWHERE. **Mesoamerica:** Mexico (Chiapas, Escobar, 1978), El Salvador; **Caribbean:** Cuba, Jamaica, Dominica, Grenada, Guadeloupe, Puerto Rico, Santa Lucia; **South America:** Argentina, Brazil, Ecuador, Guyana, Peru, Venezuela; **Africa:** Central African Republic, Gabon, Réunion, South Africa; **Asia Temperate:** China (Hainan); **Asia Tropical:** India (Tamil Nadu St.). Data on

collections from Philippines are doubtful. - On bark of fallen limbs, on many unidentified substrata, and on *Carapa procera*.

TYPES STUDIED. *Paratypes*: Florida, G.C. Fischer (Lloyd Herb. 8238) and W.W. Calkins 22 (both: BPI); Georgia, E. Bartholomew 5675 (BPI).

REMARKS. Setae of this species are of two types; embedded setae are usually only up to 35 μm long. Between the two types there are usually a few intermediates. Dendrohyphidia are abundant in mainly sterile specimens, rare or easily overlooked in fertile ones. Another species with dendrohyphidia, *H. escobarii* has sometimes seemingly resupinate but actually umbonate-adnate basidiomata and broadly ellipsoid spores (5-)5.2-6.5 x (3-)3.5-4.5(-4.8) μm . *H. pinnatifida* is sometimes very similar to specimens of *H. jobii* and *H. curtisii* which lack characteristic dendrohyphidia. **Misidentifications.** Many specimens of this fungus have been misidentified in herbaria as *H. asperata* Ell. & Everh. (= *H. epichlora*), *H. cinnamomea*, *H. corrugata*, *H. curtisii*, *H. episphaeria*, *H. insularis* (= *H. corrugata*), *H. rubiginosa*, and *H. spreata* (= *H. cinnamomea* ssp. *spreata*).

24. *Hymenochaete rhabarbarina* (Berk.) Cooke Figs. 4, 6; 5, 9

Cooke, *Grevillea* 8 (48): 148 (1880); Léger, *Hymenochaete* 233, f. 89 (1998). - *Corticium rhabarbarinum* Berk. in Hooker, *Fl. Nov.-Zel.* 2: 184 (1855).

Basidiome effused, closely adnate, soft or almost coriaceous when dry, 100-300(-700) μm thick, at first as numerous scattered patches 2-5 mm in diam, then merging to form areas up to 15 x 5 cm. Hymenium smooth or sometimes slightly tuberculate, azonate, not cracked, when old sometimes irregularly cracked, Fulvous to dark Sienna (M: 7.5 YR 6/6-6/8 or 5 YR 5/8, then 5/4; K & W: 5-6 D-E 5-6, 6 C-D 7 or 5-6 C 5, brownish orange to cocoa brown or Pompeian yellow), without lilac tint; margin indeterminate, thin, lighter coloured than hymenium when young (M: 7.5 YR 7/8-9; K & W: 5 B 6, apricot yellow), then concolorous and abrupt.

Tomentum and cortex absent; context composed of hyphal layer, or hyphal layer and thin setal layer; dark line above the hymenium usually present.

Hyphal layer 60-300(-600) μm thick; context hyphae loosely arranged, interwoven; hyphal system monomitic; setal hyphae absent; generative hyphae 2.5-4(-4.5) μm in diam, brownish, thin-walled or with thickened walls, septate, ramified at right angle; in context crystalline or amorphous matter usually present, some part of hyphae sometimes covered with brownish resinous granules.

Setae scattered (sometimes numerous), (50-)60-100(-120) x 5-8(-9.5) μm , projecting to 60-80 μm , subulate or subfusiform, with acute tip, straight or some with slightly curved tip, usually enmeshed in hyphal sheath, this usually encrusted with amorphous yellow or brownish granules in upper half.

Hyphidia absent or not numerous, hyaline or yellowish, 1-1.5 μm in diam, thin-walled, without incrustation; cystidia absent; basidioles 7-12 x 3.5-5 μm , with thickened walls, without incrustation; basidia (sub)utriform, with walls thickened at base, 15-22 x (4-)5-6(-7) μm ; sterigmata 4, 3-5 μm long; spores ellipsoid to broadly ellipsoid, with one side flattened, (4.5-)4.8-6 x 2.3-3.3 μm .

CULTURAL CHARACTERS. Léger & Lanquetin, 1987: 29.

SUBSTRATA IN N. AMERICA. *Taxodium* sp., ? *Populus* sp.

DISTRIBUTION IN N. AMERICA. MEXICO: NL (Escobar, 1978), OA (on road from Oaxaca to Valle Nacional, 10 Aug 1963 K.P. Dumont, CUP-ME 165, NY). **USA:** AZ (Pima Co, Coronado Nat. Forest, on aspen (?), 22 Jul 1980 H.H. Burdsall 10883, CFMR); LA (on cyprus tree, Humphrey 2516, BPI 278128; East Feliciana Parish, Idlewild, 27 Aug 1994 E. Parmasto, TAA 153146; St. Tammany Parish, Pearl River Wildlife Area, 28 Aug 1994 E. Parmasto, TAA 153238; Baton Rouge, Burton Plantation, 24 and 30 Aug 1994 E. Parmasto, TAA 153001, 153251).

DISTRIBUTION ELSEWHERE. South America: Argentina, Brazil, Colombia, Venezuela; **Africa:** Burundi, Kenya, Réunion, Tanzania; **Asia-Tropical:** Sri Lanka; **Australasia:** Australia, New Zealand. - On bark of dead trunks and branches of numerous angiospermic and coniferous hosts.

TYPE STUDIED. *Corticium rhabarbarinum*: New Zealand, Colenso (K, holotype).

REMARKS. Some old specimens have setae arranged in two or three obscure layers. Incrustation of setae and hyphae with reddish brown granules, a character stressed by Léger (1998), are not always both present. Spores of this species have been described as oval to ellipsoidal, 4-5.5 x 2.2-3 μm by Job (1990), ovoid to ellipsoidal, 4.5-5(-5.5) x 2.5-3.5 μm by Léger (1998). The species is very closely related to *H. cinnamomea* (ssp. *spretta*) which differs in almost cylindrical spores 4.5-6.5(-7) x 1.8-3(-3.2) μm , more slender setae (60)70-120(-150) x 5-9(-10) μm and (usually) several or many alternating layers of setae and hyphae (*H. rhabarbarina* has sometimes two layers of setae).

The type of *H. rhabarbarina* has been synonymized with *H. cinnamomea* by P. Corfixen (note at the holotype in K). I have had great difficulties with identification of *H. rhabarbarina* and was inclined to agree with Corfixen. Nevertheless, there is a small difference in spore form and mean size which is considerably larger than "normal" variability of spores of a species in Hymenochaetales. Mean width of spores of *H. cinnamomea* is 1.93-2.63(-2.79) μm , mean *Q* value is (1.83-)2.05-2.79 (35 collections from Europe, Asia, Australasia, North and South America). The extreme values indicated in parentheses have been observed in specimens collected in Argentina and Louisiana, i.e., in regions where *H. rhabarbarina* has also been found.

Mean size of spores and mean *Q* value of the specimens of *H. rhabarbarina* studied are:

5.22 x 2.62	1.99	(Argentina, BAFC 30328)
5.25 x 2.62	2.01	(LA, TAA 153098)
5.32 x 2.88	1.85	(AZ, CFMR 10883)
5.43 x 2.95	1.84	(LA, TAA 153146)
5.27 x 3.05	1.73	(LA, TAA 153001)

25. *Hymenochaete rheicolor* (Mont.) Lév.

Figs. 4, 7; 5, 1

Lév., Ann. Sci. Nat. III 5: 151 (1846); Graff, Bull. Torrey Bot. Club 45: 458 (1918); Léger, Hymenochaete 235, f. 90 (1998). - *Stereum rheicolor* Mont., Ann. Sci. Nat. Bot. II 18: 23 (1842). - *Hymenochaete sallei* Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 333 (1868); Burt, Ann. Missouri Bot. Gard. 5: 314 (1918); Lentz, Agric. Monogr. 24: 18 (1955); Reeves & Welden, Mycologia 59 (6): 1048 (1967).

Basidiome sessile-pileate (rarely umbonate-sessile and then sometimes seemingly effuso-reflexed), closely adnate, soft or papery-coriaceous and flexible when dry, (150-)250-800(-900) μm thick. Pilei 1-3.5(-5) cm long, flabelliform to dimidiate, confluent, imbricate or in rosettes up to 10 cm in diam; pileal surface densely concentrically sulcate and zonate, radiately fibrillose, silky or velutinous, dull or shiny, Fulvous to dark Sienna (M: 5 YR 4-5/8-10; K & W: 6 C-D 7-8, reddish golden to light brown), old specimens more greyish (M: 5 YR 6/4-6); margin thin, lobate, sometimes plicate, concolorous with the pileal surface or lighter coloured. Hymenium smooth, not cracked, Fulvous to dark Sienna, almost concolorous with pileal surface (M: 5-7.5 YR 4-5/6-8; K & W: 6 D 6-5, cinnamon brown to sunburn or 6 D-E 7-8, cognac to light brown), when sporulating sunburn (M: 5 YR 5/4-5; K & W: 6 D 5), without olive or lilac tint; margin concolorous but may be yellowish when young (M: 5 YR 7/10; K & W: 6 B 7, carrot red).

Tomentum of abhymenial hairs or almost indistinct; cortex absent; context composed of hyphal layer or (in some old specimens) of hyphal layer and a thickening setal layer; dark line above the hymenium absent.

Tomentum (when present) 20-50(-350) μm thick; hyphal layer 230-800 μm thick, hyphae rather loosely longitudinally arranged, in thin subhymenium adscending and more densely packed. Hyphal system monomitic; setal hyphae absent; generative hyphae 2.5-5 μm in diam, yellowish to brownish, with thickened walls to thick-walled, septate, branched usually at right angle; in context, setal stratum and hymenium crystalline matter absent.

Setal layer (when present) 50-100 μm thick; setae scattered, sometimes numerous, (60-)70-110(-135) $\times$ (8-)9-15 μm , projecting 35-90 μm , broadly subulate to conical, with almost blunt or acute tip, usually enmeshed in very thin hyphal sheaths (hyphae 1-2 μm in diam), without incrustation.

Hyphidia and cystidia absent; basidioles present, in sterile specimens very numerous, 10-20 $\times$ 2.5-3.5(-4) μm , with slightly thickened yellowish or brownish walls at base, in old specimens brownish and with thickened in whole length walls and sometimes finely encrusted; basidia clavate or subclavate, subhyaline, 15-20 $\times$ 3.5-5 μm ; sterigmata 4, 3-5 μm long; spores cylindrical, curved, 4.5-7(-7.2) $\times$ 1.5-2.5 μm .

CULTURAL CHARACTERS. Boidin & Lanquetin, 1984: 193; Job, 1986: 223.

SUBSTRATA IN N. AMERICA. *Ilex vomitoria* (1), *Myrica cerifera* (2), *Quercus virginiana* (1), *Quercus* sp. (2).

DISTRIBUTION IN N. AMERICA. MEXICO: DU (1), JA (1), M-MO and NL (Mamolejo, Castillo & Guzman, 1981), OA (1), PU (1), SL (1), TA (Guzmán, 1972), VC (14). **USA:** FL (16), MS (2), NC (G & L, 1995), SC (1).

DISTRIBUTION ELSEWHERE. Mesoamerica: Mexico (Chiapas, Yucatan), Costa Rica, El Salvador, Guatemala, Honduras, Panama; **Caribbean:** Cuba, Dominica, Grenada, Guadeloupe, Jamaica, Leeward Is., Puerto Rico, St. Lucia, St. Vincent, Trinidad; **South America:** Argentina, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Venezuela; **Africa:** Rwanda; **Asia-Temperate:** China, Japan, Taiwan; **Asia-Tropical:** India, Indonesia (Java), Malaysia (Pahang), Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam; **Australasia:** New Zealand; **Southwestern Pacific:** Fiji, Tonga. - Found on mainly angiospermic trees and bushes.

TYPES STUDIED. *Stereum rheicolor*: "Mont. orig., Nilghery, Perrotet" (S, isotype) and "Stereum. 31. Authentic" (BPI, Lloyd Herb. 29711, isotype). *H. sallei*: Cuba, Cordova, 1854 Sallé 278 (K, Herb. Berk. 1879; isotypes in BPI, "ex Herb. Bresadola" and Lloyd Herb. 29726, "Authentic").

REMARKS. Characteristic for this species are thin, flexible, silky, densely zonate basidiomata, lack of cortex, broad setae, and basidioles with thickened walls. Seemingly effused basidiomata with elevated margins are rare; I have seen only two such specimens both collected in Florida. Most specimens studied are sterile; the few specimens with spores seen by me have been collected in Mexico in March, August and October. Mean spore measurements and *Q* value are:

4.10 x 1.81	2.26	(MS, CFMR 13017)
4.27 x 1.94	2.20	(FL, BPI 278538)
4.75 x 1.92	2.48	(Mexico, XAL 104)
4.75 x 1.96	2.43	(Mexico, XAL, Guzmán 23553)
4.80 x 1.95	2.47	(Mexico, XAL 2612)
4.85 x 1.94	2.50	(Mexico, XAL 1599)
4.87 x 2.13	2.29	(Mexico, TENN 18369)
5.09 x 2.01	2.54	(Mexico, XAL, Chacon 1008)
5.40 x 2.06	2.62	(FL, CFMR 17364).

Among the specimens from the tropics identified as *H. tenuissima* (Berk.) Berk. (= *H. rheicolor*) and in some herbaria in USA, there are many collections of *H. luteobadia* and *H. villosa* (Lév.) Bres. **Misidentifications.** Some specimens of this fungus have been misidentified as *H. tabacina* or *H. badio-ferruginea* (= *H. tabacina*), including Ravenel, Fungi Americi Exsiccati no. 718.

26. *Hymenochaete rigidula* Berk. & M.A. Curtis

Figs. 2, 8; 5, 6

Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10 (46): 334 (1868); Burt, Ann. Missouri Bot. Gard. 5: 318, f. 6 (1918); Reeves & Welden, Mycologia 59 (6): 1047, f. 1 E (1967); DeFigio, Tax. anal. 46, f. 16, pl. 4 f. 16a (1970); Léger, Hymenochaete 239 (1998).

Basidiome effused or effuso-reflexed with slightly elevated margins, coriaceous to hard and brittle when dry, 200-600(-700) μ m thick, resupinate part up to 4 cm long; reflexed part short and broad, 0.5-1 cm long. Pileal surface radiately fibrillose, velutinous or strigose, shiny, with concentric zones, Umber (M: 7.5 YR 8/4; K & W: 6 E 8, hazel) with Ochreous (5 B 4, greyish orange) bands; margin thin, entire or lobate, not plicate, concolorous with the pileal surface. Hymenium smooth or slightly tuberculate when old, sometimes slightly irregularly cracked, dark Cinnamon to Umber (M: 5-7.5 YR 5.5/6-8, later darker, 4/6 to 4/4; K & W: 5-6 C 7, yellow ochre to reddish golden, or 6 D 6, cinnamon brown, then 6 E 6-7, tan to cognac), without olive tint; resupinate margin distinct (abrupt), up to 1 mm wide, lighter coloured (5 YR 7/8), then concolorous with the hymenium.

Tomentum absent, cortex or cortex-like dark line in the middle of hyphal layer sometimes present, then 20-80 μ m thick and composed of interwoven hyphae; dark line above the hymenium sometimes locally present.

Hyphal layer 100-450 μm thick, with infrequent horizontal setal hyphae; hyphal system monomitic; generative hyphae loosely to compactly arranged, in upper part longitudinally arranged, in the lower part interwoven, 3-4.5 μm in diam, yellowish, with thickened walls or thick-walled, septate, infrequently branched; setal hyphae up to 150 μm long and 4-10 μm in diam, brownish; crystalline matter absent.

Setal layer 30-250 μm thick; setae numerous, (35-)-40-60(-80) $\times$ 7-12(-18) μm , projecting to 40 μm , fusiform, straight, not sinuate, naked, tip acute, without incrustation or slightly encrusted with small crystals; embedded setae sometimes with bulbous base.

Hyphidia and cystidia absent; basidioles present, thin-walled, without incrustation; basidia clavate or subclavate, 16-22 $\times$ 5-7 μm ; sterigmata 4; spores short-cylindrical or cylindrical and slightly curved, 3.7-5(-5.5) $\times$ 1.5-2.3(-2.5) μm .

SUBSTRATE IN N. AMERICA. *Quercus* sp.

DISTRIBUTION IN N. AMERICA. USA: MS (Harrison Co, Harrison Exp. Forest, 2 Dec 1989 H.H. Burdsall 13049, CFMR), TN (Knox Co, New Hopewell, 18 Mar 1945 L.R. H[esler], TENN 16741), TX (Hardin Co, Lumberton, 20 Sep 1981 R.L. Gilbertson 13242, ARIZ).

DISTRIBUTION ELSEWHERE. Caribbean: Cuba, Grenada, Guadeloupe, Jamaica; South America: Brazil, British Guyana, Colombia, Venezuela; Africa: Kenya. - On dead wood and bark of frondose species.

TYPES STUDIED. Cuba, La Perla, C. Wright 529 (FH, holotype; S, isotype).

REMARKS. All three specimens from USA and one from Jamaica studied by me have spores; mean size and *Q* value of these are:

4.01 $\times$ 1.87	2.15	(MS, CFMR 13049)
4.08 $\times$ 1.98	2.06	(AZ, ARIZ 13242)
4.64 $\times$ 1.60	2.89	(Jamaica, XAL, Welden 931)
5.17 $\times$ 2.43	2.13	(TN, TENN 16741).

27. *Hymenochaete rubiginosa* (Dicks.: Fr.) Lév. Figs. 3, 3; 5, 7

Lév., Ann. Sci. Nat. Bot. III 5: 151 (1846); Brown, Mycologia 7 (1): 1-20, f. 1-30 (1915); Burt, Ann. Missouri Bot. Gard. 5: 332, f. 11 (1918); Davidson, Campbell & Vaughn, Tech. Bull. U.S. Dept. Agric. 785: 22, f. 3 M (1942); DeFigio, Tax. anal. 51, f. 18, tab. 5 f. 18a (1970); Chamuris, Non-stipit. stereoid fungi 157, f. 58 D (1988); Léger, Hymenochaete 242, f. 92 (1998). - *Helvella rubiginosa* Dicks.: Fr., Plant. Crypt. Brit. 1: 20 (1785).

Basidiome effuso-reflexed, usually with well developed pilei, sometimes umbonate-adnate or seemingly effused, but fixed to the substratum with an umbonate point; resupinate part up to 4 cm in diam; woody hard and brittle when dry, (300-)-400-1200(-2000) μm thick. Pilei single or a few growing together to confluent, imbricate, reniform, 0.5-3.5 cm long; pileal surface concentrically sulcate and zonate, not radiately fibrillose or rugose; velutinous or tomentose, later glabrous, reddish brown or brown to blackish (M: 5 YR 4/8 when young, then 2.5 YR 4/4-6, when old 5 YR 3-4/2; K & W: 6 D 6 - 6 F 3, light brown to dark brown); margin thin to thick, entire or lobate, not plicate, lighter coloured than pileal surface, bright Fulvous or ochraceous brown, rust

brown, later concolorous; adaxial surface of the effused basidiome concentrically zonate and sulcate, tomentose or velutinous. Hymenium smooth or with scattered round semispherical tubercles, not cracked or deeply scantily irregularly creviced when old, reddish brown or brown to blackish (M: 2.5-5 YR 3-5/4; K & W: 6 E 4 - 7 D 3 to 7 E 6, chocolate or bistre with reddish tinge, greyish brown to orange brown), without olive tint, with or without a lilac tint; margin of the resupinate part abrupt, lighter coloured than hymenium or concolorous.

Tomentum 50-250 μm thick, darker than context; cortex (20-)40-55 μm thick, hyphae densely parallel or interwoven, agglutinated, rust brown; hyphal and setal layers present; dark line above the hymenium absent.

Hyphal layer 100-500 μm thick, hyphae more or less compactly longitudinally arranged; hyphal system dimitic, but difference between skeletal and generative hyphae small; setal hyphae absent; generative hyphae 2-3.5 μm in diam, subhyaline, thin-walled; skeletal hyphae numerous, brown, (2.5-)3-5 μm in diam, thick-walled; in context, setal stratum and hymenium crystalline matter absent.

Setal layer 70-500 μm thick, composed of overlapping rows of setae; setae very numerous, 40-80(-100) $\times$ (6-)8-10(-12) μm , projecting (20-)40-60 μm , conical to fusiform, with acute tip, straight or some with slightly curved tip, naked or very rarely enmeshed in hyphal sheaths, without incrustation.

Hyphidia present but usually not well differentiated, hyaline or yellowish, 1.5-3 μm in diam, thin-walled; cystidia absent; basidioles present, 8-18 $\times$ 3.5-4 μm , without incrustation; basidia clavate or subclavate, hyaline or yellowish, 15-25(-30) $\times$ 4-6(-7) μm ; sterigmata 4, 4-5 μm long; spores elongated ellipsoid, with one side flattened, (3.5-)3.8-5.5 $\times$ (1.8-)2-2.8(-3) μm .

Causes a white pocket rot of wood.

CULTURE CHARACTERS. Davidson, Campbell & Vaughn, 1942: 22; Boidin, 1958: 213.

SUBSTRATA IN N. AMERICA. Found on about 30 species of trees and bushes, but mainly on *Quercus* spp. and *Castanea*. Mentioned by Lowe (1977) also on *Abies lasiocarpa*, but this is obviously erroneous. - *Acer saccharum* (1), *Castanea dentata* (38), *Castanea* sp. (14), *Fraxinus velutina* (1), *Holodiscus discolor* (G & L, 1995), *Juglans major* (G & L, 1995), *Liriodendron tulipifera* (2), *Myrica cerifera* (G & L, 1995), *Ostrya virginiana* (1), *Platanus occidentalis* (1), *Prosopis glandulosa* (G & L, 1995), *Prunus* sp. (1), *Quercus agrifolia* (G & L, 1995), *Q. alba* (71), *Q. bicolor* (2), *Q. coccinea* (1), *Q. gambellii* (4), *Q. garryana* (6), *Q. hypoleucoides* (1), *Q. macrocarpa* (2), *Q. palustris* (2), *Q. prinus* (1), *Q. rubra* (1), *Q. rubra* var. *ambigua* (syn.: *Q. borealis*) (1), *Q. stellata* (1), *Quercus* sp. (48). *Rhamnus crocea* ssp. *insula* (G & L, 1995), *Rhamnus* sp. (1), *Robinia pseudacacia* (4), *Sambucus caerulea* (syn.: *S. glauca*) (G & L, 1995), *Tilia* sp. (1), *Ulmus americana* (2).

DISTRIBUTION IN N. AMERICA. Common everywhere *Quercus* grows. **CANADA:** NF (DeFigio, 1970: 54), ON (4). **MEXICO:** BS (Santa Catalina Is, 2), M-MI (1), M-MO (Cuernavaca; Guzmán, 1972 and Escobar, 1978). **USA:** AL (1), AR (6), AZ (2), CA (2), CO (6), CT (16), DC (3), DE (1), FL (3), GA (3), IA (1), IL (1), IN (12), KS (7), KY (1), LA (2), MA (18), MD (10), MI (2), MN (1), MO (3),

MS (6), NC (27), NE (1), NJ (5), NM (4), NY (25), OH (10), OK (1), OR (2), PA (24), SC (2), TN (10), TX (2), VA (33), VT (1), WA (4), WI (6), WV (8).

DISTRIBUTION ELSEWHERE. **Mesoamerica:** Costa Rica, El Salvador; **Caribbean:** Cuba; **South America:** Argentina (incl. Patagonia), Chile, Colombia, Ecuador, Peru; **Europe:** all countries where *Quercus* spp. grow; **Asia-Temperate:** Caucasus, Japan, Russian Far East, Turkey; **Africa:** Kenya, Morocco, South Africa; **Asia-Tropical:** Borneo (Sarawak), India, Pakistan, Philippines, Vietnam; **Australasia:** New Zealand. - Mainly on *Quercus* spp., also on *Castanea sativa*; rarely on some other deciduous species (*Calycophyllum* sp., *Fagus orientalis*, *F. sylvatica*, *Carpinus betulus*, *Nectandra* sp., *Rhamnus* sp.).

TYPE. Possibly lost; neotype of *H. rubiginosa* (not *Helvella rubiginosa*!) is collected by Lloyd (no. 3910 in FH) in USA, Ohio, designated by DeFigio (1970: 52) and published by Job (1990: 39).

REMARKS. Resupinate basidiomata of this species are similar to *H. jobii* which is always closely adnate (also in marginal part) and lacks hyphal layer. **Misidentifications.** Several specimens filed in herbaria under the name *H. rubiginosa* are misidentified and belong to *H. tabacina*, *H. curtisii*, *H. jobii*, *H. pinnatifida* or to *H. rhabarbarina*.

28. *Hymenochaete tabacina* (Sowerby: Fr.) Lév.

Figs. 4, 3; 5, 13

Lév., Ann. Sci. Nat. Bot. III 5: 145 (1846); Burt, Ann. Missouri Bot. Gard. 5: 325, f. 9 (1918); DeFigio, Tax. anal. 37, f. 12, pl. 3 f. 12a (1970); Jung, Wood-rott. Aphyll. s. Appal. 137, f. 43 n-q (1987); Chamuris, Non-stipit. stereoid fungi 158, f. 58 C (1988); Léger, Hymenochaete 270, f. 105 (1998). - *Auricularia tabacina* Sowerby, Col. fig. Engl. fungi 1, pl. 25 (1797). - *Thelephora imbricatula* Schwein., Trans. Am. Phil. Soc. N.S. 4: 166 (1832). - *Hymenochaete imbricatula* (Schwein.) Lév., Ann. Sci. Nat. Bot. III 5: 152 (1846). - *Stereum badioferrugineum* Mont., Ann. Sci. Nat. Bot. II 20: 367 (1843). - *Hymenochaete badioferruginea* (Mont.) Lév., Ann. Sci. Nat. Bot. III 5: 152 (1846); Burt, Ann. Missouri Bot. Gard. 5: 330, f. 10 (1918). - *H. borealis* Burt, Ann. Missouri Bot. Gard. 5: 317, f. 5 (1918); Chamuris, Non-stipit. stereoid fungi 155, f. 58 A (1988); Léger, Hymenochaete 78 (1998). - *H. obesa* G. Cunn., Trans. R. Soc. New Zeal. 85 (1): 15, f. 4, pl. 1 f. 3 (1957); DeFigio, Tax. anal. 40, f. 13, pl. 4 f. 13a (1970).

Basidiome effuso-reflexed or effused, closely adnate, soft coriaceous but brittle when dry, 100-600(-700) μ m thick. Pilei confluent, imbricate, dimidiate or short and broad, 0.3-1.5 cm long; pileal surface radiately fibrillose, silky, glabrous when old, with concentric zones, rust brown, grayish or dark brown (M: 5-7.5 YR 4-5/6; K & W: 6 D 6 - 6 F 8, 7 E 4-6, cinnamon brown to deep dark brown); margin thin, entire, sometimes torn, plicate or crispate, lighter coloured (golden yellow), concolorous with the pileal surface when old. Hymenium smooth but uneven, usually concentrically zonate and sulcate, sometimes only with some broad zones, rarely tuberculose, radially or plumosely cracked (not cracked in var. *badioferruginea* (Mont.) Pilát), yellowish or golden brown, brownish with grey or slightly rosy tint, then Umber (M: 7.5 YR 4-5/4, or 6.5/5 or 7/8 when young and sporulating; K & W: 5 B 3, 6 C 3 or 6 D 4-5, greyish orange, deep brownish grey or sunburn); without a lilac tint;

margin of the resupinate part fibrillose or abrupt, lighter coloured, then concolorous with the hymenium (bright Fulvous, K & W: 5 A 3, pale orange).

Tomentum present but in old specimens sometimes almost indistinct; cortex present (in some young specimens absent); context composed of hyphal layer, or hyphal layer and one setal layer with overlapping rows of setae; thin dark line above the hymenium usually present.

Tomentum (20-)30-50(-100) μm thick, sometimes with few setal hyphae; cortex (15-)20-50 μm thick, hyphae tightly interwoven, thick-walled; hyphal layer 50-300 μm thick, lighter coloured than other layers, orange-yellow, hyphae longitudinally loosely to (towards the hymenium) compactly arranged.

Hyphal system submittic; setal hyphae present in hyphal layer but not numerous, 120-250 μm long, 7-13 μm in diam, dark brown, with very thick walls, sometimes in young basidiomata absent; generative hyphae (2.5-)3-5 μm in diam, yellowish, thin-walled or with thickened walls, septate, branches usually diverging at a right angle; skeletoids brown, thick-walled, with scarce septa; in context and hymenium crystalline matter absent.

Setal layer (when present) up to 150(-300) μm thick; setae in 2-5 overlapping rows, numerous, (50-)60-120(-150) $\times$ 7-15(-16) μm , projecting to 50(-70) μm , very rarely bifurcate at base, fusiform, with acute tip, straight or rarely some few slightly curved, naked or enmeshed in hyphal sheaths, finely encrusted with hyaline or yellowish amorphous granules or crystals in upper part.

Hyphidia and cystidia absent; basidioles present, 10-14 $\times$ 3.5-4 μm , without incrustation; basidia clavate or subclavate, 15-25 $\times$ 3.5-5 μm ; sterigmata 4, up to 4(-5) μm long; spores cylindrical, slightly curved, (4.3-)4.5-7 $\times$ 1.2-2.2(-2.5) μm .

Causes white rot of wood. Experimental study on wood rot has been made by Job & Keller, 1988.

CULTURAL CHARACTERS. Nobles, 1948: 340, 1965: 1134; Boidin, 1958: 210.

SUBSTRATA IN N. AMERICA. Found on nearly 155 species of trees and bushes. Of 560 specimens with known substrata seen, 23% were on gymnospermic substrata; among these, more than one third on Thuja, next is Abies. Most common hosts are Acer spp., next are Alnus spp. and Betula spp. Rare on Quercus (as well as in Europe). Larix is a usual host in North and East Asia; in N. America I have seen 6 collections from British Columbia, Idaho and Montana (on elev. of about 9,000 ft). - **Abies balsamea** (8), *A. canadensis* (= ?) (1), *A. concolor* (1), *A. firma* (1), *A. grandis* (13), *A. lasiocarpa* (G & L, 1995), *Abies* sp. (2), **Acer circinatum** (7), *A. glabrum* (19), *A. glabrum* var. *douglasii* (2), *A. glaucum* (2), *A. grandidentatum* (1), *A. macrophyllum* (1), *A. negundo* (G & L, 1995), *A. pensylvanicum* (5), *A. rubrum* (21), *A. saccharinum* (1), *A. saccharum* (22), *A. spicatum* (27), *Acer* sp. (43), **Alnus crispa** (1), *A. fruticosa* (G & L, 1995), *A. incana* (12), *A. incana* ssp. *rugosa* (1), *A. rubra* (syn.: *A. oregona*) (6), *A. sitchensis* (1), *A. sinuata* (4), *A. tenuifolia* (20), *Alnus* sp. (12), **Amelanchier alnifolia** (4), *A. canadensis* (1), *Amelanchier* sp. (1), **Arbutus menziesii** (1), **Arctostaphylos patula** (1), **Aristolochia californica** (3), **Betula alleghaniensis** (syn.: *B. lutea*) (9), *B. glandulosa* (Niemelä, 1985), *B. lenta* (3), *B. nana* (2), *B. occidentalis* (syn.: *B. fontinalis*) (2), *B. papyrifera* (4), *B. populifolia* (2), *Betula* sp.

(10), *Carpinus caroliniana* (1), *Carya alba* (1), *Carya* sp. (5), *Castanea dentata* (1), *Castanea* sp. (1), *Castanopsis chrysophylla* (G & L, 1995), *Ceanothus velutinus* (4), *Ceanothus* sp. (1), *Cerasus* sp. (1), *Chamaecyparis nootkatensis* (1), *C. thyoides* (1), *Clethra alnifolia* (1), *Cornus stolonifera* (2), *Corylus cornuta* (syn.: *C. californica*, *C. rostrata*) (9), *Corylus* sp. (4); *Crataegus* sp. (3), *Fagus sylvatica* var. *atropunicea* (3), *F. grandifolia* (7), *Fagus* sp. (5), *Fraxinus americana* (1), *F. nigra* (2), *F. sambucifolia* (1), *Gaultheria shallon* (1), *Hamamelis virginiana* (1), *Heteromeles arbutifolia* (1), *Holodiscus discolor* (2), *Ilex verticillata* (5), *Juniperus communis* (1), *J. virginiana* (3), *Juniperus* sp. (1), *Larix laricina* (G & L, 1995), *L. lyallii* (1), *L. occidentalis* (5), *Lindera benzoin* (2), *Liriodendron tulipifera* (1), *Lithocarpus densiflorus* (3), *Lonicera involucrata* (1), *L. periclymenum* (1), *Lonicera* sp. (1), *Lyonothamnus floribundus* (1), *Magnolia* sp. (1), *Myrica* sp. (1), *Nemopanthus canadensis* (= *N. mucronatus*?) (1), *Oplopanax horridus* (2), *Opulaster* sp. (1), *Ostrya virginiana* (8), *Paxistima myrsinites* (1), *Physocarpus malvaceus* (G & L, 1995), *Picea abies* (3), *P. engelmannii* (G & L, 1995), *P. glauca* (1), *P. x lutzii* (4), *P. mariana* (Niemelä, 1985), *P. rubens* (2), *P. sitchensis* (1), *Picea* sp. (5), *Pinus contorta* (1), *P. ponderosa* (G & L, 1995), *P. rigida* (1), *P. strobus* (3), *Pinus* sp. (1), *Platanus occidentalis* (1), *Populus balsamifera* (2), *P. balsamifera* ssp. *trichocarpa* (2), *P. grandidentata* (2), *P. tremuloides* (4), *Populus* sp. (3), *Prunus emarginata* (G & L, 1995), *P. pensylvanica* (3), *P. serotina* (1), *P. virginiana* (2), *P. virginiana* var. *melanocarpa* (1), *Prunus* sp. (5), *Pseudotsuga menziesii* (syn.: *P. taxifolia*) (6), *P. mucronata* (= ?) (1), *Pyrus malus* (1), *Quercus alba* (1), *Q. coccinea* (1), *Q. gambelii* (2), *Q. garryana* (G & L, 1995), *Q. rubra* (1), *Q. stellata* (G & L, 1995), *Quercus* sp. (2), *Rhododendron canadense* (1), *R. maximum* (2), *R. viscosum* (1), *Rhus diversiloba* (1), *Rosa nutkana* (G & L, 1995), *Rubus* sp. (G & L, 1995), *Salix alaxensis* (1), *S. alba* (1), *S. bebbiana* (2), *S. laevigata* (1), *S. scouleriana* (1), *Salix* sp. (10), *Sambucus* sp. (1), *Sequoia sempervirens* (3), *Shepherdia canadensis* (1), *Sorbus americana* (1), *S. scopulina* (G & L, 1995), *Spiraea alba* (1), *S. douglasii* (1), *S. pyramidata* (1), *Symphoricarpos albus* (syn.: *S. racemosus*) (3), *Syringa vulgaris* (1), *Taxus brevifolia* (G & L, 1995), *T. canadensis* (G & L, 1995), *Thuja gigantea* (= ?) (1), *T. occidentalis* (7), *T. plicata* (33), *Thuja* sp. (1), *Tilia americana* (1), *Tsuga canadensis* (1), *T. heterophylla* (17), *Ulmus americana* (4), *U. rubra* (1), *Ulmus* sp. (1), *Umbellularia californica* (1), *Vaccinium corymbosum* (1), *V. membranaceum* (1), *V. parvifolium* (1), *V. pensylvanicum* (= ?) (1), *Vaccinium* sp. (5), *Viburnum dentatum* (3), *V. lantanoides* (syn.: *V. alnifolium*) (2), *V. nudum* var. *cassinoides* (2), *Viburnum* sp. (2), *Vitis labrusca* (1), *Vitis* sp. (1).

DISTRIBUTION IN N. AMERICA. Rare or very rare in the southern USA (except California) and in Mexico, common northwards. Northernmost localities are in Alaska, Yukon Terr. (61°11' N, 129°07' W), in Mackenzie Distr. of Northwest Terr., in Labrador Peninsula (Quebec, 55.3° N, 77.8° W and Newfoundland, 53.5° N, 64.5° W) and South Greenland. **CANADA:** AB (G & L, 1995), BC (24), NB (3), NF (6), NT (Distr. Mackenzie; G & L, 1995), NS (4), ON (30), Prince Edward Is. (2), PQ (18), YT (1). **GREENLAND:** southernmost part south of 61°15' N (Knudsen, Hallenberg & Mukhin, 1993). **MEXICO:** BS (Santa Catalina Is., 1), OA (Guzmán, 1972; Escobar, 1978; Welden & Guzmán, 1978), VC (1). **USA:** AK (35), AL (1), AR (G & L, 1995), CA (31), CO (1), CT (11), DE (1), FL (2), GA (G & L, 1995), ID (72), KY (G & L, 1995), LA (4), MA (30), MD (3), ME (43), MI (50), MN (5), MT (49), NC (10),

ND (G & L, 1995), NH (47), NJ (20), NM (1), NY (99), OK (G & L, 1995), OR (21), PA (27), RI (2), SC (1), TN (5), UT (11), VA (13), VT (34), WA (64), WI (10), WV (6), WY (3).

DISTRIBUTION ELSEWHERE. **Mesoamerica:** Costa Rica, Panama; **Caribbean:** Trinidad; **South America:** Argentina, Guyana, Brazil, Venezuela; **Europe:** Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Ukraine, United Kingdom; **Asia-Temperate:** China, Japan, Russia; **Africa:** Rwanda, Tunisia, Zaire; **Asia Tropical:** India, Indonesia (Jawa), Malesia, Nepal, Pakistan; **Australasia:** Australia, New Zealand. - On numerous deciduous, more rarely on coniferous trees and bushes. Common in Eurasia on *Salix* spp.

TYPES STUDIED. *Auricularia tabacina*: holotype possibly lost; neotype of *H. tabacina* (not *Auricularia tabacina*!) collected by W.B. Cooke 13 Jun 1948 (NY) in USA, Idaho, designated by DeFigio (1970: 37) and published by Job (1990: 44) as if collected by Cooke on 6 Jun 1948. *H. borealis*: Canada, Ontario, London, 15 Oct 1889, J. Dearness 1017 (NY, BPI, paratypes; setal hyphae present!), USA, New Jersey, Newfield, March-April J.B. Ellis (NY, BPI, paratypes).

REMARKS. Externally very variable species. Easily recognizable thanks to presence of tomentum, cortex, and presence of setal hyphae in context. Setal hyphae are sometimes quite rare. Young and small, usually effused specimens of this species with undeveloped dark line between hyphal and setal layers have been described as *H. borealis* by Burt in 1918.

H. tabacina is rare in southern States of USA and in Mexico; data on occurrence in South America are partly doubtful: in southern part of this continent it is replaced by its vicarious counterpart *H. australis* Greslebin & Parmasto.

Most of the specimens studied are without basidia and spores; the time or season of sporulation period is unknown.

Misidentifications. Several specimens filed under the name *H. tabacina* are misidentified; these are *H. cinnamomea* ssp. *spretta*, *H. curtisii*, *H. rheticolor* and (most frequently) *H. rubiginosa*. On the other hand, *H. tabacina* has been sometimes misidentified as *H. curtisii*.

29. *Hymenochaete tenuis* Peck

Figs. 2, 7; 5, 8

Peck, Ann. Rep. N. Y. St. Mus. Nat. Hist. 40: 57 (1887); Burt, Ann. Missouri Bot. Gard. 5: 364, f. 31 (1918); Léger, *Hymenochaete* 278, f. 107 (1998). - *Hymenochaete multisetae* Burt, Ann. Missouri Bot. Gard. 5: 357, f. 25 (1918); Reeves & Welden, *Mycologia* 59 (6): 1046 (1967).

Basidiomes effused, closely adnate, coriaceous when dry, velvety, thin, 50-400(-1000) μm thick, becoming confluent, 2-10 x 1-2 cm. Hymenium smooth, finely tuberculate, azonate, when old sometimes irregularly cracked, brown, very dark brown or almost black, sometimes cinnamon brown (M: 5-7.5 YR 4-5/4 or 4/6 to 5/8 (according to Léger, 1998: 5 YR 2-3/2-4); K & W: 5 F 8, 6 E-F 7 or 6 F 8, 6 D 8, raw umber, cognac or deep dark brown, or 6 C 6, caramel brown, rarely 5 C 4-5, brownish orange), without olive or lilac tint;

margin thin, indeterminate, then determinate (abrupt), concolorous with hymenium.

Tomentum and cortex absent; context composed of setal layer of overlapping rows of setae (or only one layer of setae); dark line above the hymenium absent.

Hyphal system monomitic; setal hyphae absent; generative hyphae compactly agglutinated, erect or interwoven, 2.5-4(-4.5) μm in diam, yellowish to brownish, with thickened walls to thick-walled, branched, septate; in context and hymenium crystalline matter absent.

Setae very numerous, (25-)30-60 x (5-)6-10(-12) μm , projecting to 40 μm , fusiform-conical or subulate, with acute or very sharp, some with slightly curved tip, not sinuate or sinuate (sometimes some twisted), naked, without incrustation.

Hyphidia and cystidia absent; basidioles present, without incrustation; basidia clavate or subclavate, 12-20 x 4-5.5 μm ; sterigmata 4, 3-4.5 μm long; spores ellipsoid or subcylindrical, one side flattened or slightly concave, 4.5-5.5 x 2-2.5 μm .

SUBSTRATA IN N. AMERICA. *Sabal serratula* (3), *Thuja* sp. (1), *Tsuga canadensis* (4), *Tsuga* sp. (1). Mentioned also by G & L, 1995 on *Abies balsamea*, *A. lasiocarpa*, *Picea glauca*, *Picea* sp., *Pinus ponderosa*, *Pseudotsuga menziesii*, *Thuja occidentalis*.

DISTRIBUTION IN N. AMERICA. USA: AL (Reeves & Welden, 1967), FL (3), MI (2), NY (2), PA (2). Mentioned also by G & L, 1995: AR, AZ, MS, NM, VT.

DISTRIBUTION ELSEWHERE. Mesoamerica: Costa Rica; **Caribbean:** Cuba, Jamaica, Puerto Rico, Trinidad; **South America:** Brazil, Colombia, Venezuela. - On bark and decorticated wood of fallen limbs of coniferous and deciduous trees.

TYPES STUDIED. *H. tenuis*: USA, New York, Edmond ponds, on *Thuja*, June Peck (NYS, lectotype selected by Léger, 1998). *H. multisetae*: Cuba, Cellabos, 12/11 1914 C.J. Humphrey 2808 (BPI 348562).

REMARKS. Externally similar to *H. fuliginosa* and *H. jobii* but setae of these species are much longer, 60-110 x 7-11 μm . Basidiomata of *H. tenuis* have been described as only up to 120(-200) μm thick, but specimens collected on *Thuja* are sometimes very thick, up to 1 mm. Mean size and *Q* value of spores are:

5.14 x 2.29 2.24 (CFMR 3560)

5.20 x 2.29 2.27 (CFMR 3318)

Misidentifications. Most specimens filed under the name *H. tenuis* in herbaria have been misidentified; these belong mainly to *H. fuliginosa*, some to *H. jobii* or *H. cinnamomea*.

30. *Hymenochaete unicolor* Berk. & M.A. Curtis Figs. 2, 10; 6, 3

Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 335 (1868); Burt, Ann. Missouri Bot. Gard. 5: 342, f. 16 (1918); Reeves & Welden, Mycologia 59 (6): 1048, f. 1 I (1967); Léger, Hymenochaete 283, f. 109 (1998). - *Hymenochaete fuliginosa* Berk. & M.A. Curtis, J. Linn. Soc. Bot. 10: 335 (1868) non (Pers.) Lév. (1846).

Basidiome perennial, effused, sometimes with thickened (reflexed) black densely sulcate upper margin, closely adnate, coriaceous to woody hard when

dry, brittle, (100-)350-700(-1300) μm thick; at first as numerous orbicular patches 2-15 mm in diam, then merging and up to 20 x 5 cm; margin thin, later thick and abrupt. Hymenium smooth, azonate, irregularly cracked, sometimes lifting at the crevice edges and scaling off, Cinnamon Umber or yellowish brown (M: 7.5 YR 4.5-6/6 or 5 YR 4/4-6; K & W: 6 D 8, 6-7 E 4-5 or 6 F 8, Camel or Somalis brown), without olive or lilac tint; margin indeterminate, fibrillose or abrupt, concolorous or lighter coloured than hymenium (fulvous).

Tomentum and cortex absent; context composed of thin hyphal layer 10-200 (-300) μm thick and a thickening setal layer of indistinct overlapping rows of setae; dark line above the hymenium absent, or present as a narrow zone of intertwined hyphae of deep colour.

Hyphal system monomitic; context hyphae compactly arranged, at base interwoven; setal hyphae absent; generative hyphae 2-4.5 μm in diam, yellowish, with thickened walls; in context and setal stratum crystalline matter absent, or present in dark bands between setal rows, in hymenium absent or present.

Setae numerous, (25-)35-60 x 5-7.5(-8) μm , projecting to 40 μm , not bifurcate at base, subulate or fusiform, straight, some with slightly curved tip, not sinuate, naked or enmeshed in hyphal sheaths, without incrustation, tips acute.

Hyphidia present, not numerous, hyaline or yellowish, cylindrical or slightly conical, 2.3-3 μm in diam, thin-walled, without incrustation; cystidia absent; basidioles present, 6-10 x 3.5-4, without incrustation; basidia clavate or subclavate, 12-18 x 4-5 μm ; sterigmata 4, 3.5-5 m long; spores ellipsoid, (3.5-)4-5 x 2.4-3.2(-3.5) μm .

DISTRIBUTION IN N. AMERICA. Not yet found.

DISTRIBUTION ELSEWHERE. **Mesoamerica:** Costa Rica, El Salvador; **Caribbean:** Cuba, Jamaica, Puerto Rico; **South America:** Brazil, Colombia, Ecuador, Juan Fernández Is., Venezuela; **Asia-Temperate:** Japan; **Australasia:** Australia, New Zealand. - On dead frondose wood (*Nectandra* sp., *Nothofagus* sp.), on bark of dead branches or leaf bases of palmae (*Rhopalostylis sapida*) and on unknown frondose substrata.

TYPES STUDIED. *H. unicolor*: Cuba, C. Wright 541 (K). *H. fuliginosa*: Cuba, C. Wright 188 (K).

REMARKS. Thick specimens of *H. unicolor* are externally very similar to *H. cervina* and *H. jobii* which differ in large setae (55-110 x 7-15 μm) and different spore size (4.5-5.5 x 2.2-3.2 μm in *H. jobii*, 5-7.5 x 3.5-4.3 μm in *H. cervina*). **Misidentifications.** Most specimens filed under the name *H. unicolor* in herbaria belong to *H. cinnamomea* ssp. *spreti*; however, Massee (1890: 108) indicated *H. spreti* as a synonym of *H. unicolor*. This misinterpretation has been followed by several authors of "floristic" lists.

DUBIOUS SPECIES

31. *Hymenochaete episphaeria* (Schwein.: Fr.) Massee

Massee, J. Linn. Soc. Bot. 27: 111 (1890); Burt, Ann. Missouri Bot. Gard. 5: 362, f. 28 (1918); DeFigio, Tax. anal. 55, f. 19, pl. 5 f. 19a (1970); Léger, *Hymenochaete* 132, f. 41 (1998). - *Thelephora episphaeria* Schwein. in Fr., Elench. fung. 1: 225 (1828).

Basidiome effused, closely adnate, coriaceous to hard when dry, 80-120 μm thick, 2-5 x 1-2 cm; margin thin. Hymenium smooth, azonate, irregularly cracked, orange, yellowish or golden brown or brown (yellowish brown, light brown to brown; Ridgway: Buckhorn-brown to Tawny olive or Verona brown), sometimes with olive tint; margin indeterminate, concolorous with hymenium or lighter coloured.

Tomentum and hyphal layer absent; context composed of cortex and a setal layer, or setal layer only; setal layer present as a layer of hyphae with scattered setae in all levels of it; dark line above the hymenium absent.

Cortex 30-40 μm thick; hyphae very compactly interwoven (cemented), with thick brown walls.

Hyphal system monomitic; setal hyphae absent; generative hyphae 2.5-4 μm in diam, red-brown, thick-walled; in context and hymenium crystalline matter absent.

Setal layer 70-110 μm thick; setae numerous, 60-90(-110) x 7-12(-14) μm , projecting to 50 μm , subulate to fusiform, with almost blunt tip, straight, naked or enmeshed in hyphal sheaths, encrusted with amorphous granules or crystals in upper part.

Hyphidia absent or not numerous to numerous, cylindrical or slightly conical, to 3 μm in diam, thin-walled, without incrustation; cystidia absent; basidia subclavate or (sub)utriform, 15-21 x 3.5-4(-6) μm ; sterigmata 4; spores cylindrical or ellipsoid, 4-6.5 x 1.5-2.2 μm . (Description based on the literature data cited above.)

SUBSTRATE IN N. AMERICA. *Diatrype* sp. (Fungi, Ascomycetes).

DISTRIBUTION IN N. AMERICA. MEXICO: VC (Orizaba, J.G. Smith 571, BPI 278133; see remark below). **USA:** PA (type specimen, see below).

TYPES STUDIED. *Thelephora episphaeria*: USA, Pennsylvania, Bethlehem, in *Diatrype*, Schweinitz (PH, holotype; BPI, isotype).

REMARKS. The type is up to 100 μm thick, effused, closely adnate. Hyphal system monomitic; generative hyphae 2.5-4 μm in diam, with thickened or thick walls, sparsely branched, septate. Setae broadly conical, with obtuse tip, 45-70 x 10-15 μm . No cystidia or hyphidia; basidia not developed, no spores.

The type of this species is sterile, as well as most other specimens identified as this species and studied later by Léger (1998: 132) or by me. DeFigio (1970) and Léger (1998) described a cortex present in this species; in the specimens studied by me, this layer may be called a hyphal layer. DeFigio described the species as having uniform basidia with thickened at the base walls and spores 6.0-8.5 x 2.5-3.5 μm ; these characteristics have not been mentioned by other authors.

The identity of this dubious species is unknown; it is possible that its type and several specimens described under this name are a young state of *H. corrugata*. The other specimens studied by me are possibly young or/and sterile states of following species:

H. cervina (? *H. jobii*): New York, McLean, the Lloyd-Cornell Preserve, 5 Sep 1952 J.A. Stevenson & M. O'Brien (BPI 278134).

H. cinnamomea ssp. *spretta*: NY, Albany, *Castanea dentata*, Oct 1907 C.G. Lloyd 7120 and 44562 (BPI 278135 and 330868); Vermont, Middlebury, Oct 1907 C.G. Lloyd 7221 and 20605 (BPI 278126 and 330867); Wisconsin, LaCrosse Co, Gundersen Arboretum, 21 Sep 1979 W.B. & V.G. Cooke 57561 (BPI 299846).

H. corrugata: MA, Weston, A.B. Seymour (MOBG 18358 / BPI 0278130); [PA, Trexlertown ?] Dr. Herbst (Lloyd 20601, BPI 330866); OH, Cincinnati, A.P. & L.V. Morgan (BPI 278132).

H. rhabarbarina (?): LA, St. Martinsville, on living cypress tree, 20 Jun 1914 G.J. Humphrey 2516 (BPI 278128).

H. tenuis: TN, Memphis, 18 Feb 1914 C.L. Shear (BPI 278127).

A specimen named as *H. episphaeria* has well developed basidia and spores 5-6(-7) x 1.5 μm , slightly allantoid: Mexico, Orizaba, J.G. Smith 571 (BPI 278133). This specimen has brownish basidia with slightly thickened on base walls; possibly the description of basidia by DeFigio (1970: 56) is based on it. Identity of this collection is unknown.

32. *Hymenochaete opaca* Burt

Burt, Ann. Missouri Bot. Gard. 5: 364 (1918); Reeves & Welden, Mycologia 59: 1046 (1967); DeFigio, Tax. anal. 57 (1970); Léger, Hymenochaete 205, f. 76 (1998).

Basidiome effused, closely adnate, 100-300 μm thick; hymenium smooth, azonate, sometimes irregularly cracked, brown or dark brown, without olive or lilac tint; margin thin, abrupt, concolorous with hymenium or lighter coloured.

Tomentum and cortex absent; context composed of setal layer of overlapping rows of setae only; dark line above the hymenium absent.

Hyphal system monomitic; setal hyphae absent; generative hyphae 2-3 μm in diam, yellowish to brownish, septate, branched.

Setal layer 100-300 μm thick; setae numerous, (60-)70-90 x (7-)8-11 μm , projecting to 65 μm , fusiform, straight, encrusted in uppermost part with small crystals.

Hyphidia and cystidia absent; basidia 15-18 x 3.5 μm ; spores cylindrical, slightly curved, 5.5-7(-7.5) x 2-2.2(-2.5) μm . (Description adopted from the book by Léger, 1998.)

DISTRIBUTION IN N. AMERICA. Mentioned from AL, FL, LA and Mexico by Reeves & Welden (1967: 1047), but presumably erroneously (Léger, 1998: 205-207).

DISTRIBUTION ELSEWHERE. Caribbean: Jamaica.

REMARKS. A doubtful species, possibly closely related to *H. jobii* or *H. tenuis*.

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SCUTELLINIA SINENSIS IN EUROPE

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Abstract Five Slovak collections were identified as *Scutellinia sinensis*, recently described from China and known previously only from type collection. Additional data to enhance the original description are presented.

Key words Pezizales, China, Slovakia, new collections

MATERIAL AND METHODS

Apothecial morphology and measurements are based on fresh material. Herbarium specimens were rehydrated in distilled water for 3 hours and subsequently in 8% ammonia solution for one hour. Hand-cut sections were mounted in distilled water, Melzer's Reagent, and Cotton Blue solution in lactic acid. Measurements of the ascospores, asci and paraphyses were taken from material mounted in water.

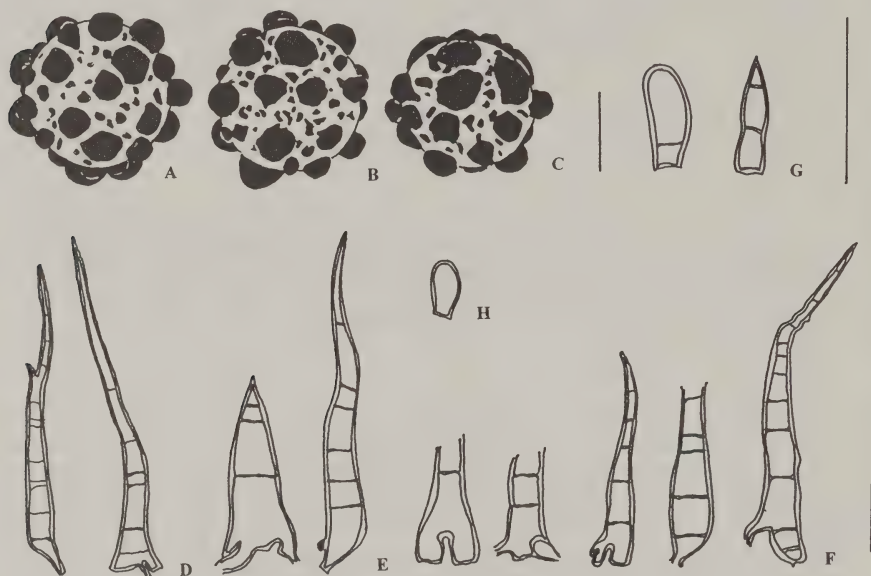
All collections studied are deposited in the herbarium of the Forestry and Wood Working Museum, Zvolen („ZVM“) and in the herbarium of the Institute of Botany, Bratislava (SAV).

Scutellinia sinensis M. H. Liu, Acta Mycol. Sinica 15: 98, 1996.

Apothecia 1-2.2 mm diam., sessile, patelliform, hymenium plane, red to brownish-red when fresh. Receptacle with stiff, yellowish-brown to rustbrown rooting hairs. Marginal hairs not significantly differing from receptacular hairs, erect, straight or slightly curved, occasionally apically forked, pointed at the apices, ventricose or gradually extended below, with simple or bi- to tri-furcate base, 2-11 septate, 135-650 µm long (-840 µm in ZVM 885) and 25-40.5 µm thick (-92 µm in ZVM 1572), with walls 2.5-5.6 µm thick. Receptacular hairs shorter. In between the marginal hairs short superficial hairs, pointed or rounded at the top, were rarely observed. Asci 8-spored, operculate, cylindrical with short attenuated base, 95-214 x 15-27 µm, pleurorhynchous. Ascospores globose or subglobose, 15.8-18.4 µm, with one large oil guttule, occasionally with de Bary bubbles, ornamented. Spore wall with both large, hemisphaerical or ovoid tubercles 2-4.5 µm high, 2.5-5.6 µm across, and small, rounded or irregular warts 0.3-1 µm high, 0.3-1.5 µm across. The outermost spore wall not separating in heated lactic acid. Paraphyses filiform, septate, enlarged at the apex to 7-12 µm.

SPECIMENS EXAMINED: China, Suiyang, Guizhou, Liu Mei Hua, 1.VIII.1984 (isotype, SAV); Slovakia, Zvolen, Arboretum Borová Hora, under *Sorbus aucuparia* on humus soil in the grass,

alt. 325 m, Glejdura, 28.VII.1997 (ZVM 884); Bratislava, Island Sihot', floodplain forest, on deposited soil, alt. 137 m, Jančovičová & Glejdura, 20.VIII.1997 (ZVM 885; Jančovičová, 2000); Zvolen, Arborétum Borová Hora, under *Carpinus betulus*, on deposited soil, alt. 305 m, Glejdura, 22.VIII.1997 (ZVM 887); Kováčová, distr. Zvolen, under *Petasites* sp., on rich humus soil, alt. 380 m, Glejdura, 12.IX.1999 (ZVM 1425); Kováčová, under *Populus tremula*, on deposited soil, alt. 360 m, Glejdura, 13.VIII.1999 (ZVM 1572).



Scutellinia sinensis. Ascospores (bar = 10 μ m): A (ZVM 885), B (ZVM 884), C (SAV, isotype). Marginal hairs (bar = 100 μ m): D (ZVM 884), E (ZVM 1572), F (SAV, isotype). Superficial hairs (bar = 100 μ m): G (1572), H (SAV, isotype).

Examination of the isotype of *Scutellinia sinensis*, which has two pieces of two premature apothecia (no "free" ascospores observed) showed few discrepancies from the original description and drawings. Liu (1996) illustrated only one type of tubercles on spore wall. But both the isotype and the Slovak collections, in addition to large tubercles, have spores with, in addition, small mostly irregular warts. the drawings of hairs in this paper fits the shape better than those in the original illustration.

Some differences were observed in the size of hairs and asci. Hairs of the isotype are slightly thicker (32-54 μ m) than in the Slovak specimens (25-40.5 μ m). On the other hand the asci in the type collection are narrower (14 -21 μ m) than in Slovak collections (15-27 μ m). These differences are within the variability of characters and have no apparent taxonomic significance.

Minute apothecia, relatively small globose ascospores with large hemispherical tubercles interspersed with small warts, and medium sized, not clearly differentiated hairs, are the most distinctive characters of *S. sinensis*. As suggested by Liu (1996) the

species seems to be closely related to *Scutellinia citrina* (Massee) Y. J. Yao & Spooner (1995) [= *S. paludicola* (Boud.) Le Gal] that differs in larger ascospores with smaller tubercles and shorter hairs.

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TWO NEW SPECIES OF *BREVICELLCIUM* AND A SURVEY OF TROPICAL AND SUBTROPICAL SPECIES IN THE GENUS (BASIDIOMYCOTINA, APHYLLOPHORALES)

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ABSTRACT

Two new species of *Brevicellicium* are described from South America viz.: *B. flavovirens* typified with a specimen from Argentina and *B. udinum* on *Podocarpus* from Brazil. Brief descriptions with distribution and a key to the species in the genus are provided.

Keywords: Corticioid fungi, South America.

BREVICELLCIUM K. H. Larss. & Hjortstam, Mycotaxon 7:117, 1978.

Generic type: *Corticium exile* H. S. Jacks.

BASIDIOMES resupinate, effused, thin or slightly thickened, pruinose, membranous, smooth, granulose or odontoid. CORDS absent. SUBICULUM generally thin, hyaline or whitish. HYPHAL SYSTEM monomitic; basal hyphae distinct, with parallel walls and proportionately long elements, subhymenial hyphae short, isodiametric (inflated), all hyphae with clamp-connections. CYSTIDIA lacking, but globose hyphal outgrowths sometimes present. BASIDIA short, almost clavate, but often slightly constricted, normally with four sterigmata and with a basal clamp-connection. SPORES thin-walled or with slight wall thickening, smooth, usually short-ellipsoid, reniform or somewhat lacrymoid, generally few in most species, inamyloid, indextrinoid and acyanophilous.

The genus is characterized by almost isodiametric subhymenial hyphae, rather short, somewhat doliiform basidia and smooth, often subangular spores with a slight wall thickening. It differs from smooth-spored species in *Trechispora* mainly by rather straight and uniform basal hyphae, never with ampullate swellings.

Key to species

1. Clamp-connections absent..... **permodicum**
1. Clamp-connections present..... **2**
2. Basidiome rather thick (100-200 μm), with a thin but distinct, more or less white subiculum, spores narrowly ellipsoid 5-6 x 2.5-2.75 μm **udinum**
2. Basidiome lacking a distinct subiculum, spores subangular, ellipsoid or allantoid..... **3**
3. Spores reniform to allantoid, 4 x 1.5-1.75 μm **allantosporum**
3. Spores differently shaped..... **4**
4. Hymenophores smooth or very slightly verrucose..... **5**
4. Hymenophores distinctly grandinioid or odontoid..... **7**
5. Subhymenial hyphae with small hook-like protuberances, spores 4-4.5 x 3.5 μm **uncinatum**
5. Subhymenial hyphae smooth, without such protuberances..... **6**
6. Hymenophore yellowish green, spores 4.5-5(-5.5) x 3-3.5 μm **flavovirens**
6. Hymenophore whitish to cream-coloured, spores somewhat lacrymoid, 4.5-5 x 2.5-3(-3.5) μm **exile**
7. Hymenophore grandinioid, verrucae more or less globose, spores asymmetric, about 5 μm across..... **olivascens**
7. Hymenophore densely odontoid or grandinioid, usually with short and conical aculei..... **8**
8. Spores subglobose, somewhat angular, 3.5-4 μm diam..... **molle**
8. Spores reniform to allantoid, 4 x 1.5-1.75 μm **allantosporum**

Brevicellicium allantosporum Hjortstam & Ryvarden, Mycotaxon 12:170, 1980.

BASIDIOME resupinate, loosely adnate, odontoid, aculei small, subulate, 0.1-0.3 mm long, whitish to greyish-white or pale ochraceous. **HYPHAL SYSTEM** monomitic; basal hyphae thin-walled 2.5-4 μm wide, subhymenial hyphae isodiametric, 7-8(-10) μm wide, all hyphae with clamp-connections. **CYSTIDIA** absent. **BASIDIA** 10-12 x 4 μm . **SPORES** reniform to allantoid, thin-walled,

often with two oildrops in the protoplasm, $4 \times (1.25-1.5-1.75 \mu\text{m})$.

Distribution: Known from the type-locality in Tanzania and from Brazil, Colombia and recently collected by P. Roberts 356/B, K(M) 26812 from Borneo (Sabah).

Brevicellicium exile (H. S. Jacks.) K. H. Larss. & Hjortstam, Mycotaxon 7:118, 1978.

Basionym: *Corticium exile* H. S. Jacks Can. J. Res. C, 28:721, 1950.

BASIDIOME resupinate, thin to moderately thin, especially when young almost athelioid, with age sometimes moderately flocculose, smooth or with small rounded elevations, whitish to creamish, in the herbarium often ochraceous. HYPHAL SYSTEM monomitic; basal hyphae thin-walled or with a slight wall thickening, uniform, subhymenial hyphae isodiametric, up to $10 \mu\text{m}$ wide, all hyphae with clamp-connections. CYSTIDIA absent. BASIDIA short, almost cylindrical, $12-15 \times 5-7 \mu\text{m}$, with four sterigmata and a basal clamp-connection. SPORES as a rule few in specimens, globose, short-ellipsoid, often with a slightly lacrymoid appearance, $4.5-5 \times 2.5-3(-3.5) \mu\text{m}$.

Originally described from Canada and seems to be a rare species in the Northern Hemisphere. Reported from Colombia (Hjortstam and Ryvarden 1997) and from the Canary Islands (Ryvarden 1976).

Brevicellicium flavovirens Hjortstam nov. sp.

Fig. 1 E-G

Basidioma resupinatum, arcte adnatum, continuum, membranaceum, leve vel leniter tuberculatum. Color flavovirens vel rufum. Systema hyphale monomiticum; hyphae basales tenuitunicatae, rectae; parietibus fere parallelis, usque ad $4 \mu\text{m}$ latis; hyphae subhymeniales plus minus indistinctae; cellulis brevibus; hyphae omnes fibulatae. Basidia subclavata, breviter, plus minus doliiformia, $10-12 \times 5-6 \mu\text{m}$, 4 sterigmatibus. Sporae ellipsoideae, tenuitunicatae, leves, paucae, $4.5-5(-5.5) \times 3-3.5 \mu\text{m}$

Holotype: Argentina, prov. Misiones, Iguazu Nat. Park, on deciduous wood, 1-5 March 1982, L. Ryvarden 20086 K(M) 80082.

Paratypes: Brazil, São Paulo, Cananeia, Ilha do Cardoso, 2-5 Feb. 1987, Ryvarden 24872 (GB); Bahia, leg. Thomas Laessøe 53195 (K)

BASIDIOME resupinate, closely adnate, continuous, membranous, smooth or slightly tuberculate, yellowish green. HYPHAL SYSTEM

monomitic; basal hyphae few, straight and uniform, hyaline, 2.5-4 μm wide, subhymenial hyphae indistinct, isodiametric, 4-7 μm wide, forming a rather dense tissue; all hyphae with clamp-connections. CYSTIDIA absent. BASIDIA short-clavate, more or less doliiform, 10-12 x 5-6 μm , with four sterigmata and a basal clamp-connection. SPORES few, broadly ellipsoid, smooth, thin-walled, 4.5-5(-5.5) x 3-3.5 μm , adaxial side convex but frequently slightly depressed near the apex.

This species is closely related to *B. exile*, but the latter is thinner, differently coloured white or grey, and has ellipsoid or slightly lacrymoid spores.

Brevicellicium mellinum (Bres.) Hjortstam & Ryvarden, Mycotaxon 10:269, 1980. *Corticium mellinum* Bres., Annls mycol. (Berlin) 18:47, 1920.

According to K. H. Larsson (thesis 1992) this is a species of *Trechispora* P. Karst.

Brevicellicium molle Hjortstam & Ryvarden Mycotaxon, 12:170, 1980.

BASIDIOME resupinate, loosely adnate, at first composed of thin threads, then continuous and slightly grandinioid with small, more or less globose verrucae. HYPHAL SYSTEM monomitic; basal hyphae straight and uniform, up to 4 μm wide, subhymenial hyphal elements isodiametric, 7-8 μm wide, all hyphae with clamp-connections. CYSTIDIA lacking, but occasionally with protruding hyphal in the basidial layer. BASIDIA short-clavate, about 10 x 6 μm , with four sterigmata and a basal clamp-connection. SPORES subglobose, subangular, thin-walled, smooth, 3.5-4 μm diam.

Distribution: Tanzania (type-locality), Colombia on wood and Brazil on *Dicksonia* sp.

Brevicellicium olivascens (Bres.) K. H. Larss. & Hjortstam, Mycotaxon 7:119, 1978. *Odontia olivascens* Bres., Fungi Trid. 2:36, 1898.

BASIDIOME resupinate, closely adnate, thin to moderately thick, normally grandinioid, more or less ceraceous when fresh, when dried almost membranous, cream, sometimes yellowish or even sulphureous. HYPHAL SYSTEM monomitic; basal hyphae uniform,

thin to moderately thick-walled, 3-3.5(-4) μm wide, subhymenial hyphae short-celled, typically isodiametric, 5-10 μm wide, all hyphae with clamp-connections. CYSTIDIA absent, but globoid hyphal outgrowths present, normally 5-10 μm wide. BASIDIA short-cylindric, 12-20 x 7 μm , with a slight median constriction, with four sterigmata and a basal clamp-connection. SPORES with a rhomboid appearance, hyaline and smooth, thin-walled, usually with one or several oil-drops in the protoplasm, approximately 5 μm diam.

Distribution: Known at least from Argentina, Brazil and Venezuela in South America, also from the Canary Islands and additionally from Burundi and India.

Brevicellicium permodicum (H. S. Jacks.) Ginns & Lefebvre, Mycol. Mem. 19:31, 1993. *Corticium permodicum* H. S. Jacks. Can. J. Res. C 28:721, 1950.

This species lacks clamp-connections and was originally compared with *Corticium exile*. It fits somewhat within the generic description of *Brevicellicium* by its subhymenial hyphae and the appearance of its spores. It is known from three specimens in Canada and was reported from New Zealand by Cunningham (1963), but no specimens have been examined.

Brevicellicium udinum Hjortstam nov. sp.

Fig. 1 A-D

Basidioma resupinatum, arcte adnatum, continuum, membranaceum, leviter rimosum, leve vel interdum modice tuberculatum. Color pallidoluteum. Systema hyphale monomiticum; hyphae basales tenuitunicatae, rectae, 3-3.5(-4) μm latae; hyphae subhymeniales indistincte isodiametrae, 5-6(-8) μm latae; hyphae omnes fibulatae. Basidia clavata, plus minus doliiformia, 16-20(-25) x 5-6 μm , 4 sterigmatibus. Sporae anguste ellipsoideae, tenuitunicatae, leves, 5-5.5(-6) x 2.5-2.75 μm .

Holotype: Brazil, São Paulo, Paraiba, Campos do Jordão, Parque Estados de Campos do Jordão, on decayed trunk of *Podocarpus*, in a moist place, 8 July 1985, Hjortstam 16124 K(M) 80083

BASIDIOME resupinate, closely adnate, continuous, membranous, cracking, 100-150(-200) μm thick, smooth or moderately tuberculate, pale yellow. HYPHAL SYSTEM monomitic; basal hyphae more or less loosely arranged in a thin, whitish tissue, 3-3.5(-4) μm wide, other

hyphae of variable appearance and width, some subhymenial hyphae isodiametric and 5-6(-8) μm across, all hyphae with clamp-connections. CYSTIDIA absent. BASIDIA clavate, somewhat dolii-form, 15-17(-20) $\times$ 5-6 μm , with four sterigmata and a basal clamp-connection. SPORES narrowly ellipsoid, smooth, thin-walled, rather few, 5.5(-6) $\times$ 2.5-2.75 μm .

Brevicellicium udinum is distinguished from other species in the genus by its rather thick basidiome with a thin, whitish subiculum and narrowly ellipsoid spores, but the isodiametric subhymenial hyphae are less conspicuous than in the generic type

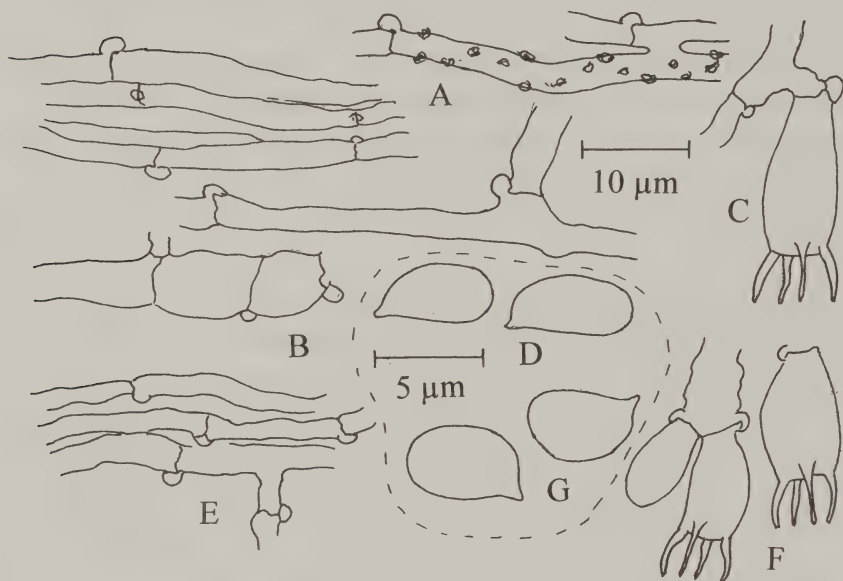


Fig. 1. *Brevicellicium udinum*. Holotype, Hjm 16124 A) different kind of hyphae B) inflated hyphae in the subhymenium C) basidium D) spores. *Brevicellicium flavovirens*. Holotype, Ryv. 20086 E) subicular hyphae F) basidia G) spores.

Brevicellicium uncinatum Hjortstam & Ryvar den, Mycotaxon 12:171, 1980.

BASIDIOME resupinate, effused, closely adnate, smooth or slightly farinaceous, whitish to greyish. HYPHAL SYSTEM monomitic; basal hyphae few, straight or widened near the septum, about 3 μm wide, subhymenial hyphae

isodiametric and sometimes up to 10 μm wide, provided with unci-form protuberances. CYSTIDIA absent. BASIDIA subglobose, 7-9 x 5-6 μm , with four sterigmata. SPORES subglobose, thin-walled, smooth, 4-4.5 x 3.5 μm , with distinct apiculus.

The unciform outgrowths and small spores distinguish this species.

Known only from the type locality in Tanzania.

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Larsson, K.H. 1992. The genus *Trechispora* (Corticaceae, Basidiomycetes). Dep. Syst. Bot. Univ. Göteborg, Sweden.

Ryvar den, L. 1976. Studies in the Aphyllophorales of the Canary Islands. 3. Some species from the western islands. Cuad. Bot. Canar. 26/27:29-40.

CORTICIOID SPECIES (BASIDIOMYCOTINA, APHYLLOPHORALES) FROM COLOMBIA III

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ABSTRACT

6 species are reported as new for Colombia of which *Botryobasidium botryoideum* and *Corneromyces kinabalui* are previously not known from South America. *Athelopsis colombiensis*, *Radulomyces subsigmoideus*, the genus *Minostroscyta* typified with *Minostroscyta discoidalis* are proposed as new taxa. The invalid generic name *Mutatoderma* is briefly discussed and *Hyphoderma brunneocontextum* Galán is considered as a substitute for *Mutatoderma brunneocontextum* Gómez.

Keywords: Corticiaceae, South America.

INTRODUCTION

This is the third paper in our series on the corticoid fungi of Colombia (Hjortstam & Ryvarden 1997, 2000). The reader is referred to Hjortstam & Ryvarden (1997) for details concerning the expedition in which the collecting was undertaken. The numbers are those of Leif Ryvarden. To avoid excessive citations of locality names, the following list indicates where the cited collections were made.

15913-16101: Magdalena province, San Lorenzo, Station Reservo, Sierra Nevada, 2100 m, 16–17 June 1978; 16102-16242: Magdalena province, San Lorenzo, Refugio de la Sierra, 1800 m, 18-19 June 1978; 16243-16310: Magdalena province, San Lorenzo, Campanero, 1200 m, 20–21 June 1978.

Symbols

* New to Colombia

! Holotype studied

LIST OF SPECIES

Athelopsis colombiensis Hjortstam & Ryvarden *nov. spec.* **Fig. 1 A-D**
Basidioma resupinatum, pelliculare, leve, albidum. Margo indistinctus. Rhizomorphae absentes. Systema hyphale monomiticum; hyphae basales tenuitunicatae vel leviter crassiusculae, raro incrustatae, strictae, uniformes, 1.75-2(-3) μ m latae, hyphae subhymeniales tenuitunicatae, irregulares, hyphae omnes fibulatae. Cystidia abunda, hyalina, leve, tenuitunicata, 25-30 x 4-6 μ m. Basidia fere cylindracea, tenuitunicata, leviter constricta, 10-12 x 5 μ m, 4 sterigmatibus. Sporae laevibus, hyalinis, ellipsoideis, tenuitunicatis, 5 x 2.75 μ m, inamyloideis, indextrinoideis, acyanophilis.

Holotype: Colombia, Magdalena province, San Lorenzo, Station Reservo, Sierra Nevada, 1900 m, on fern, 19 June 1978, L. Ryvarden 16145 (O)

BASIDIOME resupinate, loosely adnate, pellicular. Subiculum very thin, consisting of thin-walled or slightly thick-walled, rather straight hyphae. MARGIN not differentiated. Cordons absent. HYMENOPHORE smooth, whitish. HYPHAL SYSTEM monomitic; basal hyphae thin to moderately thick-walled, straight and uniform, 1.75-2(-3) μ m wide, moderately branched and with distant clamp-connections, rarely encrusted, forming a very thin subiculum. Subhymenial hyphae thin-walled, irregular, slightly broader. All hyphae with clamp-connections. CYSTIDIA abundant, hyaline, smooth, thin-walled or in age with somewhat thickened wall, moderately sinuous, obtuse or more rarely with subulate appearance, 25-30 μ m long and 4-6 μ m wide in the middle part. BASIDIA short, almost cylindric, but somewhat pedunculate and often with a slight median constriction, 10-12 x

5 μm , with four sterigmata and a basal clamp-connection. SPORES smooth, rather few in the specimens, thin-walled, narrowly ellipsoid to ellipsoid, 5 x 2.75 μm , normally single, inamyloid, indextrinoid and acyanophilous.

This species should be easily recognized by its narrow hyphae, short nearly cylindric basidia, small spores and by the abundant cystidia. It differs from the generic type *Athelopsis glaucina* (Bourd. & Galzin) Parmasto primarily by the occurrence of cystidia.

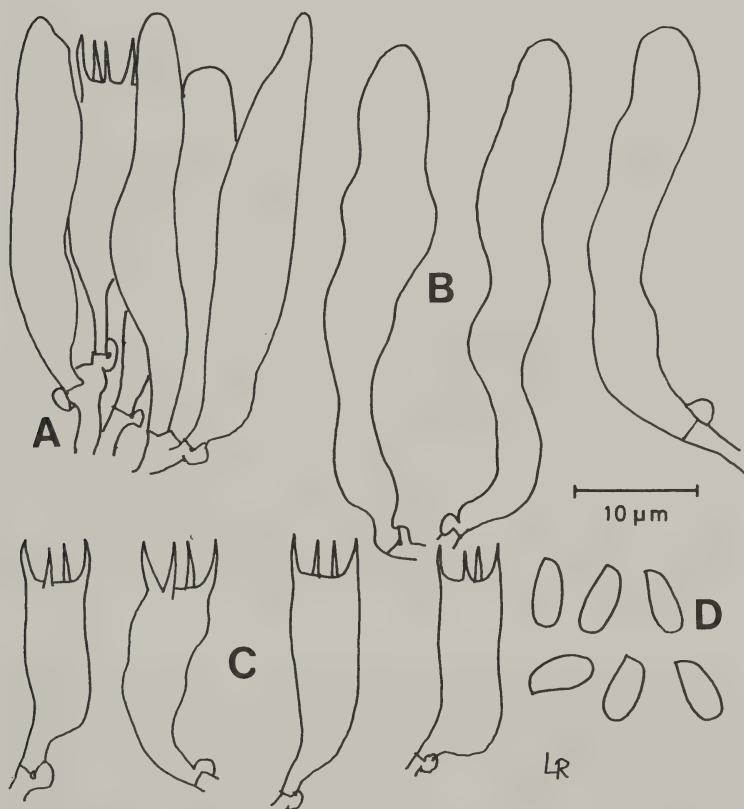


Fig. 1. *Athelopsis colombiensis*. Holotype. A) Cluster of basidia and cystidia B) Cystidia C) Basidia D) Spores (del. Ryvarden).

****Botryobasidium botryoideum*** (Overh.) Parmasto, Eesti NSV Tead. Akad. Toim. biol., seer. 14:220, 1965. – *Corticium botryoideum* Overh., Mycologia 26:510, 1934.

Specimen: 16121/B.

Never reported from tropical areas, but a rather well known species from the Northern Hemisphere, see G. Langer (1994).

Ceraceomyces* cfr. *simulans (Berk. & Broome) Hjortstam, Kew Bull. 44:312, 1989. – *Corticium simulans* Berk. & Broome, J. Linn. Soc. Bot. 14:72, 1875.

Specimen: 16084.

Description of the Colombian specimen, which is similar to the holotype, the latter having longer spores, (5-)6-7 x 2(-2.5) μm .

BASIDIOME loosely adnate and easily detached from the substratum, at first pellicular, then membranous, commonly wrinkled (merulioid) and ochraceous to pale brown, margin whitish or concolorous, thinning out or slightly fibrillose and now and then cordonic. HYPHAL SYSTEM monomitic; subiculum whitish and consisting of thin-walled or slightly thick-walled hyphae, loosely intertwined, 5(-6) μm wide, smooth and hyaline, next to the substratum often considerably wider, 6-8(-10) μm across, subhyaline to pale yellowish, all hyphae with clamp-connections. CYSTIDIA absent. BASIDIA elongate-clavate, slightly constricted, 17-20 x 4-5 μm , with four sterigmata and a basal clamp-connection. SPORES subcylindrical to somewhat fusoid, usually slightly curved or with sigmoid appearance, most matured spores 5 x 2(-2.5) μm , with a rather distinct apiculus, inamyloid, indextrinoid and acyanophilous.

Ceraceomyces simulans is extremely similar to *C. borealis* (Romell) J. Erikss. & Ryvar den, a species well known from the northern parts of Scandinavia. The spores of the latter are in general up to 8 μm long. Another similar species, is *Leptosporomyces septentrionalis* (J. Erikss.) Krieglst. (*Athelia septentrionalis* J. Erikss.). This can, however, be distinguished by its basidiome which when dried is smooth and pellicular and nearly always with a rosy tint; when fresh and fully developed it is more or less merulioid. The spores are almost navicular and slightly narrower, 5-6.5 x 1.5-2 μm .

**Corneromyces kinabalu* Ginns, Mycologia 68:970, 1976.

Specimen: 16070.

Described from Borneo (Sarawak) and one specimen from same locality was reported by Hjortstam, Spooner and Oldridge (1990). We have also seen material from Ecuador, Nuñes No. 304 (O).

**Hyphoderma brunneocontextum* Galán, Darwiniana 32:239, 1993. A substitute for *Mutatoderma brunneocontextum* Gómez in Gómez & Loewenbaum, Bol. Soc. Argent. Bot. 17:347, 1976. Holotype: Argentina, Buenos Aires, Punta Lara, on *Pouteria salicifolia*, April (on the label) 1975 Gómez 2587 (BACF 24060)! However, it should be noted that Galán did not mention *nom. nov.*, but in our opinion it can clearly be interpreted as a such.

The generic name *Mutatoderma* (Parmasto) Gómez (Gómez & Loewenbaum 1976) was not validly published according to the ICBN 33:2 because the basionym was omitted. Consequently, the new species *M. brunneocontextum* and all combinations on page 346 in that paper are also invalid i.e. *M. mutatum*, *M. heterocystidium*, and *M. populneum*.

BASIDIOME resupinate, effused. HYMENOPHORE more or less smooth, greyish. SUBICULUM distinct, more or less tomentous, brownish. HYPHAL SYSTEM monomitic; subicular hyphae brownish, thick-walled, 4-5(-6) μm wide, smooth or slightly encrusted, subhymenial hyphae hyaline 4-5 μm wide, thin-walled to moderately thick-walled, all hyphae with clamp connections. CYSTIDIA of two kinds; 1) METULOIDS rather common, thick-walled, 20-40(-50) μm long, hyaline, subhyaline or pale yellowish brown. 2) thin-walled cystidia more or less clavate, hyaline, up to 100 μm long and approximately 10-12 μm wide in the middle part. BASIDIA 25-35 x 5-8 μm , with four sterigmata and a basal clamp connection. SPORES cylindric, sometimes subballantoid, (7.5-)8.5-11 (-12.5) x (3.25-)3.5-3.75(-4.5) μm , inamyloid, indextrinoid and acyanophilous.

The species should be easy to recognize by its brown and felted subiculum, two kinds of cystidia and relatively large and cylindric spores. An extremely similar species is *Hyphoderma variolosum* Boidin et al. described from Africa (Central African Republic), but separated by its lack of felted subiculum and longer spores, generally up to

15 μm long. See further Boidin, Lanquetin and Gilles (1991). *Hyphoderma variolosum* also occurs in Argentina and Colombia (Hjortstam & Ryvarden 2000) and was reported from Taiwan by Wu (1997). *Hyphoderma brunneocontextum* has not previously been reported from Colombia.

****Hyphodontia gamundiae*** Greslebin & Rajchenberg, *Mycologia* 92:1159, 2000.

Specimen: 15655/B (Colombia, Cundinmarcha, Paramo, Summa Paz 3800 m.a.s.l., L. Ryvarden 7.VI.1978).

This specimen was erroneously reported as *Hyphodontia wrightii* by Hjortstam and Ryvarden (1997).

****Hypochnicium punctulatum*** (Cooke) J. Erikss., *Symb. bot. ups.* 16:101, 1958. – *Corticium punctulatum* Cooke, *Grevillea* 6:132, 1878. Specimen: 16099.

A cosmopolitan species, but variable especially with regard to the size of the spores.

Minostrocyta* Hjortstam & Ryvarden *nov. gen.

Basidioma disciforme, hymenophoro levi vel subtiliter rugoso, systemate hyphali dimitico, hyphis tenuitunicatis, hyalinis, fibuligeris, hyphis sceleticis moderate ramosis, crassitunicatis, cyanophilis, cystidiis levibus, tenuitunicatis, basidiis clavatis, 4 sterigmatibus, sporis subfusiformibus, levibus, tenuitunicatis, in typo 15-18 x 4-6 μm , inamyloideis, indextrinoideis, acyanophilis.

Typus generis: *Minostrocyta discoidalis* Hjortstam & Ryvarden

Minostrocyta discoidalis* Hjortstam & Ryvarden *nov. spec.

Fig. 2 A-D

Basidioma disciforme, laxe adnatum, leve, subiculo byssaceo, albido, margo leviter filamentoso, hymenophoro levi vel subtiliter rugoso, systemate hyphali dimitico, hyphis tenuitunicatis, hyalinis, 3-4(-5) μm latis, fibuligeris, hyphis sceleticis moderate ramosis, crassitunicatis, 1.5-2 μm latis, cyanophilis, cystidiis levibus, tenuitunicatis, tubularibus, constrictis et sinuosis, 50-100(-120) μm . Basidia clavata, 40-50(-80) x 5-7 μm , 4 sterigmatibus, sporis subfusiformibus, levibus, tenuitunicatis, 15-16(-18) x (4-)4.5-5(-6) μm , inamyloideis, indextrinoideis, acyanophilis.

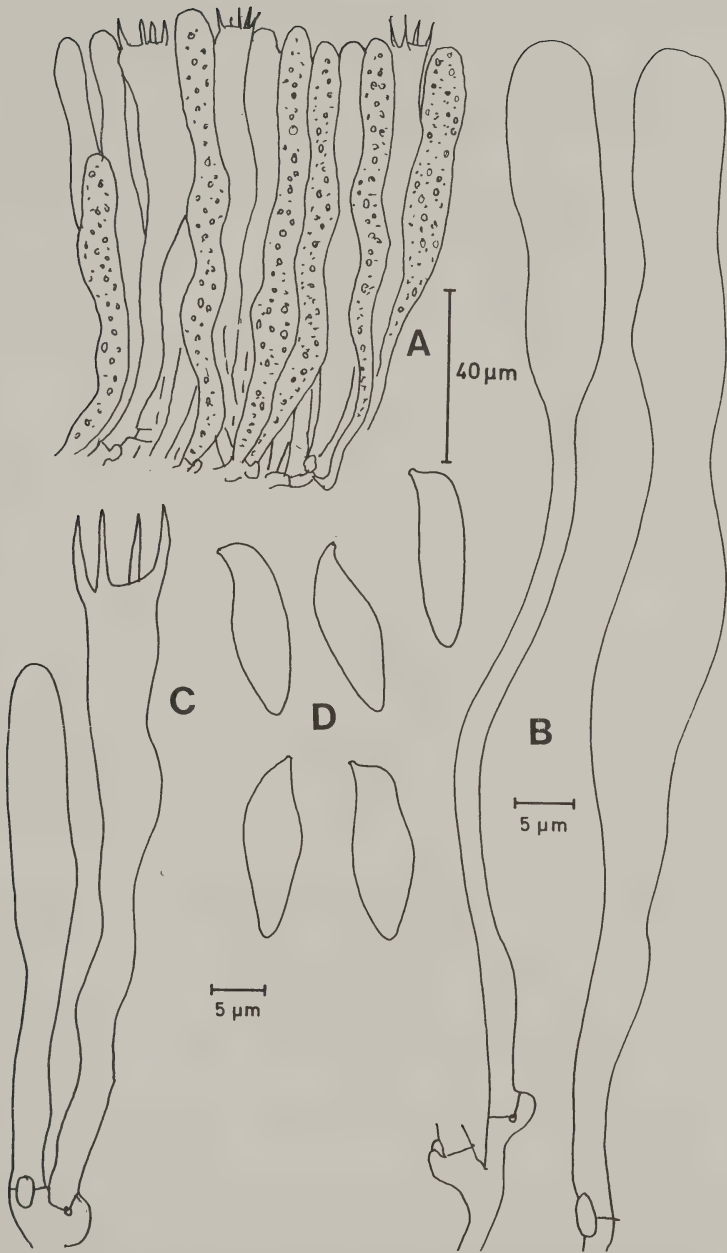


Fig. 2. *Minostrocyta discoidalis*. Holotype. A) Cluster of basidia and gloeocystidia B) Gloeocystidia C) Basidia D) Spores (del. Ryvarden).

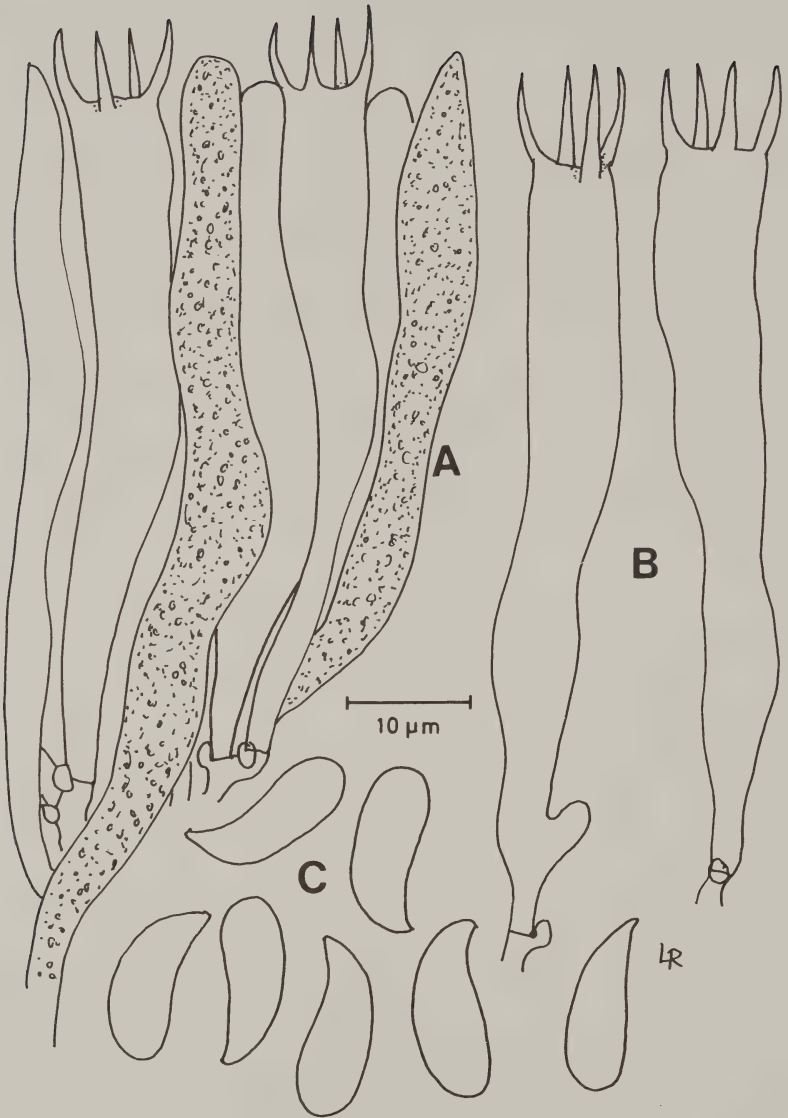


Fig. 3. *Radulomyces subsigmoideus*. Holotype. A) Cluster of basidia and (gloeo)cystidia B) Basidia C) Spores (del. Ryvarden).

Holotypus: Colombia, Magdalena, Sierra Nevada de Santa Marta, Reserva Forestal San Lorenzo, 19 June, 1978, leg. L. Ryvarden 16081 (O).

Etymology: *Minostrocyta* (anagram of *Scytinostroma*) and *discoidalis* (orbicular).

BASIDIOMES apparently originating from bark cavities, more or less discoid, about 1 cm diam., rather soft, that of the holotype less than 2 mm thick. SUBICULUM distinct, cottony, whitish. MARGIN coated with short filaments, concolorous or paler than the fertile part. HYMENOPHORE creamy, smooth to slightly tuberculate or finely wrinkled. HYPHAL SYSTEM dimitic; generative hyphae thin-walled, hyaline, 3-4(-5) μm wide, with clamp-connections; skeletal hyphae few, hyaline, moderately branching, thick-walled, 1.5-2 μm wide, with cyanophilous wall, indextrinoid and inamyloid. CYSTIDIA abundant, smooth, arising from the subhymenial layer and forming together with the basidia a rather dense hymenial palisade, in shape tubular, thin-walled, constricted and sinuous, oleous, 50-100(-120) μm long and normally ca. 10 μm in the middle part, negative in sulfovanillin. BASIDIA clavate, narrowing towards the base, 40-50(-80) μm long and about 5-7 μm below the four sterigmata, with a basal clamp-connection. SPORES subfusiform in face view, often with a distinct concavity near the apiculus, smooth, thin-walled, with homogeneous contents, 15-16(-18) x (4-)4.5-5(-6) μm , inamyloid, indextrinoid, acyanophilous.

The disciform basidiome, dimitic hyphal system with cyanophilous skeletal hyphae, large cystidia and proportionately big and subfusiform spores constitute a unique combination of characteristics, which justify both a new genus and species. It may be recognized in the field by its small-sized basidiomes living on bark, under a microscope characterized chiefly by the large basidia and characteristic spores.

Radulomyces subsigmoideus Hjortstam & Ryvarden *nov. spec.*

Fig. 3 A-C

Basidioma resupinatum, arcte adnatum, continuum, membranaceum, leviter rimosum. Color fere stramineus. Systema hyphale monomiticum; hyphae basales tenuitunicatae vel modice crassitunicatae, hyalinae, 4-5 μm latae; hyphae subhymeniales aliquantum irregulares;

hyphae omnes fibulatae. Cystidia numerosa, 80-100 x 7(-10) µm, pallide lutea in KOH. Basidia primus unciformia, 50-70 x 6-8 µm, 4 sterigmatibus. Sporae fere amygdaliformes, leviter sigmoidea, tenuitunicatae, leves, 12-14 x 4.5-5 µm, apiculo indistincto.

Holotype: Colombia, Magdalena, Sierra Nevada de Santa Marta, Reserva Forestal San Lorenzo, 19 June 1978, L. Ryvarden 16093 (O). Paratypes (O and Hjm priv. herb.): 16107, 16156 (rather poor).

BASIDIOME resupinate, closely adnate, continuous, membranous, somewhat cracking, 100(-200) µm thick. HYMENOPHORE smooth, yellowish-brown. SUBICULUM distinct, whitish to pale ochraceous. HYPHAL SYSTEM monomitic; hyphae thin-walled to moderately thick-walled, hyaline, about 4-5 µm wide, in the subhymenium somewhat irregular with variable width; all hyphae with clamp connections. CYSTIDIA numerous, 80-100 µm long and 7(-10) µm wide in the upper part, often originating from the subicular layer and then reminding of oleaginous hyphae, pale yellowish in KOH, negative in sulphovanillin. BASIDIA initially often with a basal hook, up to 50-70 x 6-8 µm, with four sterigmata and a basal clamp-connexion. SPORES almost almond-shaped, with a sigmoid appearance, broader towards the base, smooth, thin-walled, 12-14 µm long and 4.5-5 µm near the base, with an indistinct apiculus, inamyloid, indextrinoid, acyanophilous.

In the morphology of the hyphal system, basidia and spores this new species shows affinity with the type of *Radulomyces* (*R. confluens* (Fr.:Fr.) M.P. Christ.), except that cystidia occur. The somewhat hooked (sublateral) basidia also recall *Uncobasidium* Hjortstam & Ryvarden, but in that genus the basidia are much more pronounced with a distinct lateral hook and the clamp-connection is lacking in its normal place, see further description and illustration of *Uncobasidium luteolum* Hjortstam & Ryvarden (Hjortstam & Ryvarden 1978).

****Rogersella griseliniae*** (G. Cunn.) Stalpers. New Zeal. J. Bot. 23:305, 1985. – *Corticium griseliniae* G. Cunn., N.Z. Dept. sci. industr. Res. Bull. 145:330, 1963. – *Rogersella asperula* Liberta & Navas, Can. J. Bot. 56:1780, 1978. Holotype: Venezuela, Liberta & Navas 21-51, ISU 1640 (ISU). – *Hyphodontia griseliniae* (G. Cunn.) E. Langer, Bibl. Mycol. 154:120, 1994.
Specimens: 16153, 16244.

Mainly due to the ornamented spores we prefer to use the generic name *Rogersella* instead of *Hyphodontia*, see further E. Langer (1994). It should be noted that in 16153 there are projecting outgrowths, obviously a hyphomycetous fungus, but very similar to lagenocystidia such as in *Hyphodontia alutaria* (Burt) J. Erikss. It is difficult to discern the origin of these elements, but apparently they are growing from clampless hyphae in the hymenial layer, not belonging to *R. griseliniae*.

****Scytinostroma galactinum*** (Fr.) Donk, Fungus 26:20, 1956. – *Thelephora galactina* Fr., Acta R. Soc. Sci. Upsal. III, 1:136, 1851. – *Corticium galactinum* (Fr.) Burt, in Moffatt Chicago Acad. Sci. Bull. 7:137, 1909.

Specimens: 16094, 16106 and probably 15951.

The known tropical distribution of *S. galactinum* s.l. seems to be USA (Florida), Mexico, Hawaii, Venezuela, Brazil and Australia. It should be noted that Boidin and Lanquetin (1987) described several ultraspecies of which *S. neogalactinum* Boidin & Lanq. is distributed in Central America (Guadeloupe and Martinique).

****Scytinostroma ochroleucum*** (Bres. & Torrend) Donk, Fungus 26:20, 1956. – *Gloeocystidium ochroleucum* Bres. & Torrend, Broteria Ser. bot. 11:81, 1913.

Specimen: 16200.

This seems to be a cosmopolitan species, but nowhere common. In South America further known from Guadeloupe (Boidin & Lanquetin 1987), Argentina (Tierra del Fuego, Iguazu) and Brazil.

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HYPHOMYCETES FROM LEAF LITTER OF MICONIA CABUSSU IN THE BRAZILIAN ATLANTIC RAIN FOREST

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ABSTRACT

55 Hyphomycetes were recorded during an inventory of microfungi associated with leaf litter of *Miconia cabussu* in the Brazilian Atlantic rain forest fragment in the State of São Paulo. *Beltrania malaiensis*, *Chaetendophragmia triangularia*, *Chalara cylindrosperma*, *C. microspora*, *Endophragmiella boewei*, *Heniscospora coronata*, *Menisporopsis pirozynskii*, *Rhinocladiella selenoides*, *Selenodriella perramosa*, *Selenosporella curvispora*, *Speiropsis scopiformis*, *Subulispora longirostrata*, *Tirramulispora gracilis* and *Zygosporium echinosporum* were collected for the first time in Brazil. Descriptions and comments are provided for the aforementioned taxa.

Key words: microfungi, mitosporic fungi, South America, “Serra do Mar”.

INTRODUCTION

This mycological investigation was carried out in the Biological Reserve of Paranapiacaba, situated in the Municipality of Santo André, State of São Paulo, Brazil (23°46'S lat.; 46°18'W long.), with an area of 336ha (Domingos et al., 1994). The Reserve is situated on the edge of a plateau, next to the “Serra do Mar” Complex in a

Köppen system, the local climate is Cfb, with mean annual precipitation of 3381 mm, a relative humidity of about 100% and an average annual temperature of 18°C (Struffaldi-De Vuono, Domingos & Silveira-Lopes, 1989).

The Reserve represents a transitional region between the tropical humid and subtropical forests, with a typical Atlantic Rain Forest vegetation, originally with high species richness (trees, lianas and epiphytes) and complex structure (Coutinho, 1962). The local vegetation is characterized as secondary, and is seriously affected by atmospheric pollution from the industrial complex of Cubatão (Struffaldi-De Vuono et al., 1989; Leitão Filho et al., 1993) with 23 industries, that expel into the atmosphere, approximately 230 distinct pollutants (Domingos et al., 1994). The main ones are fluoride gases, sulfur dioxide, nitrogen oxide, ammonia, hydrocarbons and particulate materials (Klump et al., 1996).

Miconia cabussu Hoehne (Melastomataceae) is a pioneer heliophytic species and is very frequent in Atlantic Rain Forest secondary vegetation (Medeiros, 1993). This species is recommended for vegetational recomposition of "Serra do Mar" region (Bononi et al., 1989) and as a possible passive biomonitor organism (Domingos et al., 1994).

Some work on fungal taxonomy and ecology has been performed in this Reserve (Grandi, 1998; 1999; Grandi & Gusmão, 1996; Schoenlein-Crusius & Milanez, 1998), but few new records for Brazilian mycota were discovered. The present work contributes to a better knowledge of microfungial geographical distribution and species richness associated with leaf litter of *M. cabussu*, a plant that has never been studied before in this aspect.

MATERIAL AND METHODS

Leaf litter was collected in six distinct stations of the Reserve for 1 year (October/1995-October/1996) every two months. The leaves were washed thirty times with sterile distilled water and then incubated in moist chambers (Harley & Waid, 1955). As the fungi developed, sporulating structures were mounted on permanent slides with PVL resin (Trappe & Schenck, 1982) and deposited in the Herbarium "Maria Eneyda P. Kauffmann Fidalgo" of the "Instituto de Botânica" (SP).

DESCRIPTIONS OF SPECIES

Beltrania malaiensis E. M. Wakefield, Kew Bull. 4: 204. 1931.

Setae not observed. **Conidiophores** arising from radially lobed basal cells, solitary or numerous, determinate, erect, straight or flexuous, unbranched, smooth, brown at the base and light brown at the apex, 64.5-250 X 3.5-6 µm. **Conidiogenous cells** integrated, terminal, poliblastic, denticulate, light brown. **Separating cells** oval or globose, 1-denticulate at each end, light brown, 11.5-16.5 X 6-9.5 µm. **Conidia** arising from the conidiogenous cells or the separating cells, solitary, biconic, continuous, smooth, light brown, with a hyaline transverse equatorial band, 26-37.5 X 13-22 µm; apex of conidia with a small conical appendix, smooth, pale brown, 5-10 X 2-2.5 µm.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 30 Dec. 1995, SP251233; L.F.P. Gusmão, 22 Apr. 1996, SP251234.

The first record of *B. malaiensis* is from 1924, isolated on *Dichopsis gutta* in Malaya territory (Pirozynski, 1963). Vittal & Dorai (1995) recorded this species on *Eucalyptus tereticornis* from India. Our record is the third for the world and the first outside Asia.

Known distribution: Malaya (Pirozynski, 1963), India (Vittal & Dorai, 1994/1995).

The material collected in Brazil has longer separating cells and wider conidia. This species is characterized by its conidial morphology, with a small conic apical appendage. The other species of this genus have a longer appendage, except *B. africana* Hughes, which has a small one (up to 2 µm). The presence of setae is a common feature of *Beltrania* species, except in *B. malaiensis* where they are rather infrequent (Pirozynski, 1963). Another interesting observation on the Brazilian material is the presence of 2-6 denticles on the conidiogenous cells, a feature not previously observed in this species. According to Pirozynski (1963) only one, or rarely two, denticles have been observed on the type material.

Chaetendophragmia triangularia Matsush., Microfungi of the Solomon Islands and Papua-New Guinea, Kobe, p. 12. 1971.

Conidiophores solitary, erect, unbranched, straight or flexuous, septate, fertile an apex, light brown, 39.5-80 X 3.5-4 µm. **Conidiogenous cells** with annellidic percurrent proliferation; distance between annellations, 11.5-14 µm. **Conidia** solitary, triangle to obclavate, base truncate, apex and lateral with an appendage, smooth, 4-septate, light brown, 27.5-32.5 X 5.5-8 µm; **apical appendage**, subulate, hyaline, 15-30 X 1.5-2 µm; **lateral appendage** arising at quarter basal cell, 0-2 in number, hyaline, 23-29.5 X 1.0-1.5 µm.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 04 Jul. 1996, SP251242.

Known distribution: Papua-New Guinea (Matsushima, 1971), Japan (Matsushima, 1975), Taiwan (Matsushima, 1980) and Peru (Matsushima, 1993).

The genus *Chaetendophragmia* was described by Matsushima from the type species *C. triangularia* isolated on leaves of *Castanopsis* sp., in Papua-New Guinea (Matsushima, 1971). This species was later isolated on other substrates by the same author: Matsushima (1975, 1980, 1993). The material examined on *M. cabussu* has smaller conidiophores and conidia. The isolate from *Quercus glaucae* (Matsushima, 1975) is more similar to the Brazilian material. Up to now, four species and one variety are recognized in this genus. *Chaetendophragmia triangularia* is distinguished from other species by the shape of conidia and the number and position of appendices.

Chalara cylindrosperma (Corda) Hughes, Can. J. Bot. 36: 747. 1958.

Conidiophores simple, erect or flexuous, septate, smooth, brown, 57.5-96.5 µm long (including phialide); conidiogenous cells phialidic, lageniform, pale brown, 32-40 µm

long; venter ellipsoid, 12.5-15 X 5.5-7 μm ; collarette cylindrical, 19-21 X 2.5-3 μm ; abrupt transition between venter and collarette. **Conidia** solitary or on persistent catenate, cylindrical, rounded at the apex and truncate at the base, aseptate, smooth, hyaline, 10.5-19 X 1.5-2 μm .

Material examined: BRAZIL, São Paulo: Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 22 Apr. 1996, SP251247.

Known distribution: Italy (Lunghini & Quadraccia, 1991) and Austria, Canada, Czech Republic, Cuba, United States of America, France, India, Poland, New Zealand, Great Britain, Russian (Mercado Sierra, Holubová-Jechová & Mena Portales, 1997).

This species probably has a cosmopolitan distribution (Mercado Sierra et al., 1997) and has been isolated from numerous substrates (Nag Raj & Kendrick, 1975; Holubová-Jechová, 1984). The Brazilian material is similar to the specimen observed by Nag Raj & Kendrick (1975). The morphology and dimensions of the conidiophores and conidia are typical for this species.

Chalara microspora (Corda) Hughes, Can. J. Bot. 36: 747. 1958.

Conidiophores not produced. **Phialide** arising directly on vegetative hyphae or basal cell, solitary or aggregated in a few groups, cylindrical, obclavate to lageniform, simple, erect, smooth, pale brown, 35.5-58 μm long; venter subcylindrical, 19-30 X 2.5-6 μm ; collarette cylindrical, 13.5-20.5 X 1.5-2 μm ; gradual transition between venter and collarette. **Conidia** cylindrical with truncate ends, persistent catenate, aseptate, smooth, hyaline, 7-14 X 1-1.5 μm .

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 13 Nov. 1995, SP251246.

Known distribution: Argentina (Arambarri, Gamundi & Bucsinszky, 1981), Czech Republic, United States of America, Poland (Holubová-Jechová, 1984).

C. microspora has been isolated from many substrates: old members of Hydnaceae (Basidiomycetes) and *Quercus* sp. (Nag Raj & Kendrick, 1975), *Fraxinus excelsior*, *Picea abies* (Holubová-Jechová, 1984) and *Nothofagus dombeyi* (Arambarri et al., 1981). The Brazilian material presents longer venter and conidia. The most closely related species is *C. austriaca* (Fautr. & Camb.) Nag Raj & Kendrick; however, in this species the conidia are smaller and the color is dark brown. The main characteristics are the catenate conidia and the morphology of phialides. According to Nag Raj & Kendrick (1975) the gradual transition between venter and collarette is rare in this species, a feature observed on Brazilian material.

Endophragmiella boewei (Crane) Hughes, N. Z. J. Bot. 17:147. 1979.

Conidiophores solitary, simple, erect, straight or flexuous, septate, smooth, brown at the base, light brown at apex, 134.5-291 X 4-5.5 μm . **Conidiogenous cells** cylindrical, integrated, monoblastic, percurrently proliferated, with constrictions at each succession pole, light brown, 6.5-19 X 2.5-3 μm . **Conidia** pyriform, smooth, 1-septate, distal cell larger than proximal cell, light brown, 17-20 X 11-13 μm ; truncate base of the proximal cell, 2-2.5 μm wide.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 23 Jan. 1996, SP251257.

Known distribution: Japan (Matsushima, 1975), United Kingdom (Sutton, 1978), Taiwan (Matsushima, 1980), Cuba (Castañeda Ruiz, 1986), Formosa, New Caledonia, Italy, United States of America (Mouchacca & Zucconi, 1994) and South Africa (Crous, Seifert & Castañeda Ruiz, 1996).

Sutton (1978) mentioned that *E. boewei* was observed from several substrates. The Brazilian material fits well to the descriptions provided by the literature, except for the longer conidiophore and smaller conidiogenous cells. Mulas, Pasqualetti & Rambelli (1993) tested the influence of seven different types of substrates on the morphology of *E. boewei* and reported that there was not a great influence on the morphology. In natural conditions, this species is characterized by the morphology of conidia and the typical percurrent proliferation.

Henicospora coronata Sutton & Kirk, Trans. Brit. Mycol. Soc. 75: 249. 1980.

Conidiophores not observed. **Conidia** solitary, cylindrical, rounded at apex, closed or opened at the base (resulted of rhexolytic detachment), with 3 dark transverse septa, the upper two cells are divided in two delimited hyaline vacuoles and lower cells in only one, smooth, pale brown, 18.5-25.5 X 3.5-5 µm.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 22 Apr. 1996, SP251262.

Known distribution: Australia, United States of America (Hawaii), Western Samoa, Trinidad (Kirk & Sutton, 1980), Cuba (Castañeda Ruiz & Arnold, 1985), India (Dorai & Vittal, 1987), South Africa (Sinclair, Eicker & Morgan-Jones, 1990), New Caledonia (Mouchacca & Zucconi, 1994).

Up to now, this species was only collected on leaf litter of *Eucalyptus* ssp. (Mouchacca & Zucconi, 1994). The Brazilian material has smaller conidia than those described in the literature and it does not always have a distinctly coronate apex, as Sinclair et al. (1990) mentioned. The conidia are very typical of this species, mainly because of the presence of three dark thickened transverse septa and rhexolytic detachment.

Menisporopsis pirozynskii Varghese & Rao, Bot. Notiser 131: 215. 1978.

Conidiomata synnematus; with a prominent central seta, solitary, smooth, septate, brown, 132-202 X 5-6.5 µm. **Conidiophores** aggregated in parallel fascicles, ascendant around central setae, pale brown, 60.5-148 µm (including conidiogenous cells).

Conidiogenous cells integrated, terminal, monophialidic, pale brown. **Conidia** aggregated in slimy masses around apex of conidiomata, fusiform to allantoid, solitary, 0-septate, smooth, hyaline, 15.5-19 X 3-4.5 µm, with 2-4 appendages at each end of conidia; **appendages** with varying length, hyaline, 6-10.5 µm.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 24 Jan. 1996, SP251265; L.F.P. Gusmão, 28 Oct. 1996, SP307229.

Known distribution: India, New Caledonia (Mouchacca, 1990b), Argentina (Cabello, Cazau & Arambarri, 1993), Malaya (Matsushima, 1996) and Cuba (Castañeda, Cano & Guarro, 1997).

The number, disposition and length of the appendages of the conidia are the main characteristics of this species (Castañeda et al., 1997). These same authors reported that these features are a unique configuration of *M. pirozynskii*. The closest related species is *M. pleioisetosa* Vasant Rao & de Hoog, (Rao & de Hoog, 1986) and it is separated by its elliptical conidia, the uniform number and the equal length of the appendage at both poles (Castañeda et al., 1997).

Rhinocladiella selenoides (de Hoog) Onofri & Castagnola, Mycotaxon 18(2): 342. 1983.

Conidiophores straight or flexuous, septate, smooth, pale brown, 30-36.5 X 3-3.5 µm.

Conidiogenous cells integrated, terminal, sympodially proliferated, denticulate;

Conidia solitary, selenoid, apiculated apex, base with plane scars, gutulate, 0-septate, smooth, brown, 17-20.5 X 6-7 µm.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 22 May 1996, SP307237.

Known distribution: Tanzania (Pirozynski, 1972), India (Subramanian & Sudha, 1978), Taiwan (Matsushima, 1980), Ivory Coast (Onofri & Castagnola, 1983), Australia (Matsushima, 1989) and Ecuador and Peru (Matsushima, 1993).

The Brazilian specimen has shorter conidiophores and conidia when compared to the previously described material (Matsushima, 1980; 1993; Onofri & Castagnola, 1983; Subramanian & Sudha, 1978). *R. selenoides* is characterized by the morphology of conidium and the presence of denticles at the apex of the conidiophore. Subramanian & Sudha (1978) reported that there are two types of conidia, lenticular and selenoid. This distinct morphology is probably related to variation conidiogenesis, as observed in *R. aquaspersa* (Iwatsu et al., 1987). In the Brazilian material, only selenoid conidia were observed.

Selenodriella perramosa Kendrick & Castañeda Ruiz, Univ. Waterloo Biol. Ser. n° 33: 36. 1990.

Conidiophores erect, straight or flexuous, verticillate conidiogenous cells or branches, septate, smooth, brown at the base, light brown at the apex, 122-176.5 X 5-6 µm.

Conidiogenous cells polyblastic, indeterminate, flask shaped, in verticils, simpodially proliferated, finely denticulate, smooth, light brown, 8-13.5 X 2.5-4 µm. **Conidia** needle-like or fusiform, 0-septate, smooth, hyaline, 4.5-5.5 X up to 1 µm.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 07 Nov. 1995, SP307238.

Known distribution: Cuba (Castañeda Ruiz & Kendrick, 1990).

This species was originally collected on decaying leaves of *Nectandra coriacea* and apparently has a restricted distribution. The conidiophores and conidia are small when

compared to the material described by Castañeda Ruiz & Kendrick (1990), but the features observed in Brazilian material forced us to consider it as belonging to *S. perramosa*. Bhatt & Kendrick (1993) reported that *Selenodriella* has reproductive morphological characteristics quite similar to species of *Selenosporella* Arnold ex MacGarvie, and *Idriella* Nelson & Wilhelm, but *S. perramosa* is distinguished from other species mainly by the presence of verticillate branches at the conidiophores.

Selenosporella curvispora MacGarvie, Scient. Proc. R. Dubl. Soc., Ser. B, 2: 153. 1968.

Conidiophores, solitary, erect or flexuous, septate, smooth, brown, 42-89 X 4.5-5.5 µm

Conidiogenous cells polyblastic, obclavate, up to 4 per verticil, denticulate, smooth, light brown, 10.5-19 X 3.5-5 µm. **Conidia** fusiform, slightly curved, cylindrical-angular, 0-septate, smooth, hyaline, 4.5-5.5 X 0.5-1 µm.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 28 Oct. 1996, SP307239.

Known distribution: Japan (Matsushima, 1975), Great Britain (Kirk, 1983), Australia, France, India, Ireland, Italy (Lunghini & Quadraccia, 1991), Peru (Matsushima, 1993) and Mexico (Heredia et al., 1995).

The conidiophores are smaller than the previously described material (MacGarvie, 1968; Ellis, 1971). The disposition of the conidiogenous cells and the morphology of conidiophores are the main characteristics of this species. Sutton & Hodges (1977) reported that the conidia is a good characteristic for the separation of the species from others, but Kirk (1982) revealed that the dimensions and the shape of conidia are very variable in the strains of *S. curvispora* collected around the world. Matsushima (1989) reported that the conidia do not germinated in common culture media. According Heredia et al. (1995), this species was collected a few times in neotropical regions.

Speiropsis scopiformis Kuthubutheen & Nawawi, Trans. Br. Mycol. Soc. 89: 584. 1987.

Conidiophores simple, straight or flexuous, septate, smooth, brown, 45.5-80 X 3.5-5.5 µm; apex of the conidiophore with small branches in which conidiogenous cells arise. **Conidiogenous cells** clavate to lageniform, integrated, polyblastic, sympodially proliferated, smooth, light brown, 1-3 denticles in the apical region, 5.5-13.5 X 3.5-5.5 µm. **Conidia** unite by an isthmus forming an unbranched chains with 4-7 cells, cylindrical or cuneiform, simple, 0-septate, smooth, hyaline to light brown, 32.5-50.5 µm long; intermediary conidia, cylindrical, 6-9.5 X 3-4.5 µm; terminal conidia, cuneiform, 5.5-7 X 2.5-3.5 µm; catenate conidia difficult to detach.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 01 Nov. 1995, SP307240.

Known distribution: Malaysia (Kuthubutheen & Nawawi, 1987), New Caledonia (Mouchacca, 1990a) and Cuba (Castañeda Ruiz et al., 1998).

The description provided by Mouchacca (1990a) corresponds to our species, but in the original description, the conidiophores are much large when compared with

Brazilian material (Kuthubutheen & Nawawi, 1987). The principal characteristics of this species are the morphology and the unbranched disposition the catenate conidia.

Subulispora longirostrata Nawawi & Kuthubutheen, Mycotaxon 30: 459. 1987.

Conidiophores simple, erect or flexuous, geniculate at the apex, 2-3 septate, smooth, brown at the base and light brown in apex, 42.5-63.5 X 3.5-4.5 μm . **Conidiogenous cells** integrated, terminal, sympodially proliferated, smooth, light brown. **Conidia** solitary, subuliform, truncate at the base, apex with appendage, 1-3 septate, smooth, hyaline, 28-35.5 X 2.5-4 μm . Appendage filiform, smooth, hyaline, 14.5-22 μm long. Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 24 Oct. 1995, SP307243.

Known distribution: Malaysia (Kuthubutheen & Nawawi, 1987).

The Brazilian material is similar to the type material (Kuthubutheen & Nawawi, 1987). This species is characterized by the morphology of the conidia and the filiform appendage with a small inflexion at the junction of conidia. Up to now, *S. longirostrata* does not have a large distribution and this is the second record of this taxon in the world.

Triramulispora gracilis Matsush., Icones Microfungorum a Matsushima Lectorum, Kobe, p. 158. 1975.

Conidiophores not observed. **Conidia** composed of a central axis and three branches; central axis obclavate, truncate base, acute apex, 1-2 septate, hyaline, 25-30.5 X 2.5-3 μm ; branches obclavate, 0-1 septate, hyaline, 13-26 X 1.5-3 μm ; apex, 1-1.5 μm wide. Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 13 Mar. 1996, SP307249.

Known distribution: Japan (Matsushima, 1975), Mexico (Heredia et al. 1995).

This species was originally collected on decaying leaves of unidentified tree (Matsushima, 1975) and *Quercus xalapensis* (Heredia et al., 1995). The dimensions of the structures of the previously described material (Matsushima, 1975; Heredia, et al., 1995) are large, but this species has conidia very characteristic when compared to other species in the genus. Heredia et al., (1995) revealed that Mexican collection exhibit much smaller dimensions if compared to Matsushima's diagnoses. Ando (1993) reported that the number of branches are considered an important characteristic to identify the species.

Zygosporium echinosporum Bunting & Mason, Mycol. Pap. 5: 135. 1941.

Conidiophore unbranched, smooth, septate, brown, 10-13.5 X 3-4 μm , arising from the vegetative hyphae or from the stipe. **Stipe** straight, long, smooth, light brown, with a expansion at the apex, 98-154.5 X 3-4 μm . **Stipe expansion** rounded, subhyaline, 4.5-5 μm diam. **Vesicles** arising from the conidiophore, curved, smooth, dark brown, 11.5-12.5 X 7-8 μm . **Conidiogenous cells** arising from vesicles, in number of 3-4, ampuliform or ellipsoidal, discrete, determinate, monoblastic, smooth, light brown to hyaline. **Conidia** rounded, 0-septate, verrucose, hyaline, 6-8 μm diam.

Material examined: BRAZIL, São Paulo, Biological Reserve of Paranapiacaba, L.F.P. Gusmão, 04 Mar. 1996, SP307255.

Known distribution: British Isles, Ghana, Japan, Mexico, Nigeria, Peru, Serra Leoa, Trinidad, Taiwan, United States of America (Hawaii) (Heredia et al., 1997).

The typical features of this species are the presence of the expansion in the apex of conidiophore stipes and the disposition of the vesicles. The Brazilian material is similar to that previously described (Ellis, 1971; Kirk, 1983). Kirk (1983) reported that the size of the conidia is not a good character to distinguish any species included in this genus. The vesicles are responsible for the forcible discharge of conidia, when humidity varies (Ingold, 1971).

OTHER SPECIES FOUND ON *M. CABUSSU*

Arthrobotrys oligospora Fresenius, Beitrage zur Mykologie, 1-2: 18. 1850.

Material examined: L.F.P. Gusmão, 08 Dec. 1995, SP251232.

Beltrania rhombica Penzig. Nuovo G. bot. ital., 14: 72. 1882.

Material examined: L.F.P. Gusmão, 02 May 1996, SP251236.

Beltraniella japonica Matsushima, Icones Microfungorum a Matsushima Lectorum, p. 15, 1975.

Material examined: L.F.P. Gusmão, 04 Mar. 1996, SP251238.

Beltraniella portoricensis (F.L. Stevens) Pirozynski & Patil, Can. J. Bot. 48: 575. 1970.

Material examined: L.F.P. Gusmão, 22 Apr. 1996, SP251237.

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A NEGLECTED CALICIOID LICHEN NEW TO TAIWAN

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Abstract: There are no previous records of any member of the Coniocybaceae in Taiwan. This paper reports the presence of *Chaenotheca chrysocephala* there.

Keywords: *Chaenotheca chrysocephala*, Coniocybaceae

Chaenotheca chrysocephala has been reported from Yunnan, China (Zahlbruckner 1930, Wei 1991), Japan (Yoshimura 1974), and Nepal (Awasthi & Awasthi 1989). For the distribution in Europe, Siberia and North America see Tibell (1975, 1980, 1999). It is also known from the Southern hemisphere (Tibell 1987, 1998).

Recently during a collecting trip to the mountainous area in central Taiwan, we collected among many others a lichen which may represent the first record of the family Coniocybaceae in Taiwan (cf. Lai 2001, an updated lichen checklist of 144 genera, 579 species and infraspecific taxa enumerated). We express our deep gratitude to Prof. Leif Tibell, Department of Systematic Botany, Uppsala University, Sweden who assisted in verifying the identity of it as *Chaenotheca chrysocephala*. It was found on the north side near the base of an old *Tsuga chinensis*.

Chaenotheca chrysocephala (Turn. ex Ach.) Th. Fr., Acta Reg. Soc. Sci. Ups. 3: 250. 1860.

Calicium chrysocephala Turn. ex Ach., Methodus qua omnes detectos Lichenes, suppl.: 15. 1803.

Thallus corticolous, verrucose to squamulose, yellowish green. Apothecia black, stalked, stalk 1-2 mm. Capitulum obconical, lower side and stalk yellow-pruinose. Spores simple, pale brown, spherical to ellipsoid, 4-6 μ m. Phycobiont a Chlorococcales.

Thallus K-, C-, KC-, P-; TLC: vulpinic acid.

Distribution: Cool to temperate areas of both hemispheres, and higher elevation at low latitudes.

Specimens examined. TAIWAN. Taichung County: Anmashan Forest Station,

2275 alt., upper montane vegetation zone, on trunk of *Tsuga chinensis*. Wetmore 85364 (MIN), *Lai s. n.* Feb. 1, 2001 (LAI).

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TYPE SPECIMEN STUDIES IN NEW WORLD LENTINULA

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ABSTRACT

Discovery of two biological species within putative *Lentinula boryana* led to examination of type specimens of names previously listed in synonymy under *L. boryana*. Shape of cystidia and spore dimensions were diagnostic in assigning each type collection to a morphological species. *Armillaria raphanica* is the most priorable basionym representing the "non-*boryana*" taxon, and the epithet is recombined in *Lentinula*.

KEY WORDS: nomenclature, specimen studies

INTRODUCTION

Lentinula boryana (Berk. & Mont.) Pegler and *L. guarapiensis* (Speg.) Pegler have been considered to be the only New World species within *Lentinula*, the latter species known only from its type collection (Pegler, 1983a). Until now, *L. boryana* has been reported from the tropics of Mexico, Central America, Caribbean landmasses and South America to subtropical North America (Hibbett et al, 1998; Nicholson et al, 1997; Mata et al., 2000; Murrill, 1916; Pegler, 1983a; Petersen et al, 1998).

Mating experiments involving several specimens of putative *L. "boryana"* from Mexico, Costa Rica, Puerto Rico, Florida and the Gulf Coast area of North America revealed the presence of two intersterility groups (Petersen et al, 1998), a conclusion supported by independent genetic and molecular data (Hibbett et al, 1998; Nicholson et al, 1997). Macroscopically, basidiomata of the two intersterility groups were indistinguishable, but microscopic analyses showed that they could be separated into two morphotaxa distinguished by the shape of cheilocystidia, caulocystidia, and basidiospore dimensions (Mata et al, 2000; Petersen et al, 1998). Consequently, these micromorphological characters gained more taxonomic importance when identifying *L. boryana* and sister taxa. Previous comprehensive studies which included *L. boryana* and putatively synonymous names left the presence of cystidia unnoticed (Singer, 1952, 1955; Pegler, 1975, 1983a,b) although these structures were reported by other authors (Horak, 1968; Guzmán et al, 1997).

The objective of this paper was to determine which of the two biological species is to be represented by the name *L. boryana*, and to apply the most priorable name (if any) to the other biological species. To answer this question, examination of type specimens of epithets listed by Pegler (1983a) as synonymous under *L. boryana* was carried out. This

paper reports on the morphological characters of type specimens and develops a nomenclator for the two morphospecies. In those cases where designation of type specimens was not explicit (Pegler, 1975, 1983a,b) or type specimens were missing, proper typification has been proposed according to Art. 9.9, 9.10 and 9.11 of the ICBN (Greuter, 2000).

MATERIAL AND METHODS

Morphological observations. All macroscopic observations were performed on dried material. Fungal contaminants detected on basidiomata were removed with a fine-tipped brush. Sections of basidiomata were rehydrated first in 95% ethanol and then in water for as long as 24 hours, and then placed in 3% KOH. Preparations were observed under phase contrast microscopy or bright field with Congo Red and/or phloxine. Melzer's reagent was used to test for amyloidity.

Terminology. Basidiospore measurements and statistics are as follow: range of spore length X spore width is given for all measured basidiospores; n = total number of spores measured, $\bar{x}$ = arithmetic mean of spore length and spore width for all spores measured; Q = spore length divided by spore width, indicated as a range of variation in n spores measured; $\bar{Qx}$ = arithmetic mean of Q-values. Color names in quotations are from Ridgway (1912), names followed by alphanumeric codes in parentheses are from Kornerup and Wanscher (1978).

RESULTS

Agaricus boryanus Berkeley & Montagne. 1849. Ann. Sci. Nat., Bot. Ser. 3, 11: 235.

HOLOTYPE: Brazil, Bahia, Blanchet, no. 24, K [!]

≡ *Collybia boryana* (Berk. & Mont.) Saccardo. 1887. Syll. Fung. 5: 240.

≡ *Gymnopus boryanus* (Berk. & Mont.) Murrill. 1916. North Amer. Fl. 9: 370.

≡ *Armillaria boryana* (Berk. & Mont.) Murrill. 1939. Bull. Torrey Bot. Club 66: 31.

≡ *Lentinus boryanus* (Berk. & Mont.) Singer. 1955. Sydowia 9: 379.

≡ *Lentinula boryana* (Berk. & Mont.) Pegler. 1975. Kavaka 3: 19.

Basidiomata three, pressed and glued on white cardboard; two basidiomata with lamellae upwards, the other showing surface details of the pileus; one basidiome with a complete stipe, one basidiome partially damaged by insects. **Pileus** 3-4 cm diam, circular in shape, probably convex when fresh, surface subvelutinous to subfibrillose (but epicutis apparently missing over some areas), apparently hygrophanous at disc, translucent outwards, light brown (5C6 to 5D6) at disc, darker yellowish brown (5E8) towards margin. **Lamellae** adnate, but seceding (probably during drying), forming a pseudo-collarium, close to crowded, now ± concolorous with pileus; margin entire or eroded; lamellulae in at least three tiers. **Stipe** now 1.5 X 0.2-0.3 cm, central; ± widened at apex and base, striate to sulcate, fibrillose near apex, becoming twisted downwards, in middle section bumpy to warty, dark brown (6F8). No evidence of annulus or velar remains.

Pileipellis a compact, repent layer of interwoven hyphae; hyphae 4-12 μm diam, $\pm$ gelatinized, with clamp connections, hyaline singly, light brown in mass; walls thin. **Pileus trama** loosely interwoven; hyphae 4-16 μm diam, with clamp connections, hyaline; walls 2-4 μm thick. **Lamellar trama** parallel; hyphae 4-14 μm diam, with clamp connections; walls up to 1.6 μm thick. Hymenium composed of two elements: 1) **basidia** 12-16 X 3-4 μm , clavate; sterigmata 1-4; and 2) **basidioles** equal in size to basidia, clavate to ampullaceous; numerous. **Pleurocystidia** not observed. **Cheilocystidia** (Fig. 1a) 14-21 X 4-10 μm , clavate to broadly clavate, uncommon, often collapsed; apex obtuse. **Stipe trama** parallel; hyphae 2.5-7 μm diam, with clamp connections, hyaline singly, straw color in mass; walls 1-2 μm thick. **Caulocystidia** (Fig. 1b) 12-44 X 3-8 μm , clavate to subventricose; apex obtuse, sub-mucronate or sub-ampullaceous. **Basidiospores** (Fig. 1c) 4.8-6.4 X 2.4- 3.2 μm , ($n = 20$, $x = 5.9 \times 2.7 \mu\text{m}$, $Q = 1.71-2.67$, $Qx = 2.24$), ellipsoid, subovoid to subcylindrical, compressed laterally or partially collapsed, hyaline, inamyloid; wall smooth, thin.

Comment: Singer (1955) and Pegler (1975, 1983a,b) overlooked the presence of cystidia (cheilo-, caulo-) in this type. Because of the preservation process of the type basidiomata, tissues became cemented, giving them a caramelized appearance. As a result, initial distinction of individual cells under light microscopy was very difficult. Only after prolonged re-hydration and squashing of the tissues could cheilocystidia, caulocystidia, and basidiospores be observed. Shape of cheilocystidia and caulocystidia in *A. boryanus* range from clavate to broadly clavate (i.e. subsphaeropedunculate) closely resembling the shape of those structures in modern collections of *L. boryana* (Guzmán et al, 1997; Mata et al, 2000; Petersen et al, 1998). Basidiospore dimensions and other microstructures of this type collection also coincide with those observed by us in fresh material. Singer (1955) reported gelatinization of the hymenophoral and pileus trama, which we have observed in some modern collections, but like Pegler (1983a) we do not consider this phenomenon as taxonomically informative as spores and cystidia, because of its irregular manifestation. Our observations agree with those of previous authors on other characters such as disposition of lamellar trama, hyphal width, and arrangement and composition of the pileus epicutis.

Lentinula boryana is the most priorable name for any morphospecies of *Lentinula* in the New World exhibiting the above combination of micromorphological characters.

Agaricus ixodes Montagne. 1854. Ann. Sci. Nat., Bot. Ser. 4, 1: 95.

HOLOTYPE: Guyana, Leprieur, no. 982 (ex Patouillard # 4055) FH [!]

≡ *Collybia ixodes* (Mont.) Saccardo. 1887. Syll. Fung. 5: 232.

≡ *Lentinus ixodes* (Mont.) Singer. 1952. Lilloa 25: 479.

Basidiomata two, pressed flat, moldy, one complete, the other broken. **Pileus** about 40 mm diam, probably convex when fresh, tan; surface glabrous; margin curved. **Lamellae** seceding, crowded, narrow. **Stipe** about 30 X 3 mm, slightly eccentric, fibrillose, with scattered squamulae, tough. No evidence of veil or annulus.

Pileipellis a compacted, repent layer of interwoven, radially arranged filamentous hyphae; hyphae 2-8 μm diam, pigment-encrusted, light brown in mass, with clamp connections; wall thin. **Pileus trama** loosely interwoven; hyphae 4-10 μm diam,

hyaline, with clamp connections; wall up to 3 μm thick. **Lamellar trama** regular to subregular, sometimes interwoven; hyphae 2-20 μm diam, hyaline, with clamp connections; wall up to 1.6 μm thick. **Basidia** 15-18 X 4-7 μm , clavate; sterigmata 4. **Pleurocystidia** not observed. **Cheilocystidia** (Fig. 2a) 15-23 X 4-8 μm , clavate to broadly clavate, occasionally sphaeropedunculate; wall smooth, thin. Lamella margin sometimes fertile. **Stipe trama** parallel; hyphae 3-9 μm diam, straw colored, with clamp connections; wall up to 1.6 μm thick. **Caulocystidia** not observed. **Basidiospores** (Fig. 2b) 5.2-7.2 X 2.4-3.2 μm ($n = 40$, $x = 6.1$ X 2.7 μm ; $Q = 1.75$ -3.00, $Qx = 2.27$), subcylindrical to ellipsoid, $\pm$ lacrymoid-ellipsoid in side view, hyaline, inamyloid; wall thin, smooth.

Comment: Singer (1955) reported cystidioles but under our criterion these are basidioles. In our study, size and shape of cheilocystidia and basidiospores were similar to those of the type specimen of *A. boryanus*. The lamellar margin was caramelized and cheilocystidia were not as readily evident as in the type of *A. boryanus*. Absence of caulocystidia can be explained by the preservation condition of the material. We conclude that *A. ixodes* is a taxonomic synonym of *A. boryanus*.

Armillaria raphanica Murrill. 1943. Mycologia 35: 423.

HOLOTYPE [FLAS, F 17949, missing; J. Kimbrough, pers. comm.]. LECTOTYPE [*hic designatus*]: U.S.A., Florida, Sanchez Hammock, near Gainesville, 23.VII.1938, col. West & Murrill, TENN 16075 ["part of type" *teste* Murrill] [!], ISOLECTOTYPE FH [!],

Basidiomata six, in excellent condition, two attached to woody substrate. **Pileus** now 15-35 mm diam, broadly convex; surface smooth, now light brown (5C7 to 6D8), margin incurved to inrolled. **Lamellae** seceding (apparently from drying), crowded, light brown (6C8 to 6C5); margin entire, several lamellulae of different lengths. **Stipe** now 20-30 X 2-4 mm, central to eccentric, $\pm$ equal to slightly enlarged at base; surface fibrillose to scaly towards base, longitudinally sulcate and somewhat twisted, similarly colored as pileus; consistency tough.

Pileipellis a simple cutis; hyphae 3-6 μm diam, filamentous, tightly interwoven, hyaline singly, light brown to tan in mass, inamyloid, with clamp connections; wall thin. Oleiferous hyphae occasional. **Pileus trama** 200-400 μm thick, loosely interwoven; hyphae 6-16 μm diam, hyaline, with clamp connections; wall 0.8-1.6 μm thick. **Lamellar trama** regular to subregular; hyphae 6-8 μm diam, hyaline, inamyloid, with clamp connections; wall thin to 0.8 μm thick. Subhymenium 8-15 μm thick, 3-4 cells thick, not clearly distinct from trama. **Basidia** not observed. Basidioles 11-19 X 3-6 μm , clavate to ampullaceous, hyaline, inamyloid. **Pleurocystidia** not observed. **Cheilocystidia** (Fig. 3a) 17-28 x 5-8 μm , mostly clavate, rarely sphaeropedunculate, lobed or knobbed at apex, hyaline, inamyloid; with clamp connections. Not readily evident, often collapsed. **Stipe trama** parallel; hyphae 4-14 μm diam, hyaline singly, yellowish in mass, with clamp connections; walls 2-4 μm thick. **Caulocystidia** (Fig. 3b) 18-24 X 4-5 μm , cylindrical or clavate, flexed; apex obtuse, or as small knobs or outgrowths, scattered. **Basidiospores** from paratype at TENN (Fig. 3c) 4.8-6.0 X 2.4-2.8 μm ($n = 20$, $x = 5.4$ X 2.6 μm ; $Q = 1.71$ -2.67, $Qx = 2.09$), ellipsoid to subcylindrical, hyaline, inamyloid, wall thin wall, smooth.

Comment: Murrill (1943) distinguished this taxon from *A. boryanus* (*Armillaria boryana sensu* Murrill) by the closer and narrower gills, and a radish odor when drying. Spores could not be found in any basidiomata of the specimen at FH but they were measured from the type at TENN. The size of the basidiospores reported by Murrill (1943), $5 \times 2 \mu\text{m}$, falls within the range of our measurements, and spore dimensions are similar to other type specimens of *Lentinula*. Cheilocystidia and caulocystidia, not reported by Murrill, are relatively smaller than those found in any of the types of synonyms under *L. boryana*, are much more contorted and knobbed, and less apically inflated. Cystidia and spore shape and dimensions fit well with those observed in modern collections of *Lentinula* from the Gulf Coast of the U.S.A., Puerto Rico, Costa Rica and Venezuela which are supported by molecular and genetic data (Hibbett, 1999; Mata et al, 2000; Petersen et al, 1998). The holotype at FLAS (F 17949) could not be located (Kimbrough, pers. com.) and TENN 16075 serves as the best collection to be designated here as the lectotype for the name *A. raphanica*.

Following the dictates of the ICBN, we have chosen *A. raphanica* over *Gymnopus alliaceus* as the correct epithet for the "non-*boryana*" biological species on which we will report in another publication.

Armillariella umbilicata Patouillard. 1899. Bull. Soc. Mycol. France 15: 191.

LECTOTYPE [*hic designatus*]: Guadeloupe, Basse Terre, Camb Jacob, 20.III.1898, coll. Duss, no. 579, FH [!]

≡ *Armillaria umbilicata* (Pat.) Saccardo & Sydow. 1902. Syll. Fung. 16: 19.

Basidiomata 15, moldy, in fair condition. **Pileus** 0.5-40 mm diam, convex when young, aplanate-umbilicate with age; surface glabrous, now wrinkled, dark brown; margin inrolled, persistent. **Lamellae** seceding, close to crowded, rufous to rusty brown; margin entire. **Stipe** 15-20 X 1-3 mm, central, equal; surface striate to sulcate, fibrillose, dark brown.

Pileipellis a repent layer of compacted, filamentous hyphae; hyphae 3-6 μm diam, hyaline singly, light brown in mass, with clamp connections; wall thin. **Pileus trama** loosely interwoven; hyphae 4-9 μm diam, hyaline, with clamp connections; wall up to 2.4 μm thick. **Lamellar trama** regular; hyphae 4-10 μm diam, hyaline, with clamp connections; wall up to 0.8 μm thick. **Basidia** 15-22 X 6-7 μm , clavate; sterigmata 4. **Pleurocystidia** not observed. **Cheilocystidia** (Fig. 4a) 20-42 X 9-18 μm , sphaeropedunculate, occasionally broadly clavate; apex obtuse, occasionally knobbed, hyaline; wall smooth. **Stipe epicutis** parallel; hyphae 4-11 μm diam, hyaline singly, light brown in mass, with clamp connections; wall 1.6-2.4 μm thick. **Caulocystidia** not observed. **Basidiospores** (Fig. 4b) 5.6-7.2 X 2.4-3.2 μm ($n = 24$, $x = 6.1 \times 2.9 \mu\text{m}$, $Q = 1.75$ -2.50, $Qx = 2.07$), ellipsoid to subcylindrical, hyaline, inamyloid; wall thin, smooth.

Comment: Basidiospore and cheilocystidia measurements resemble those found in *A. boryanus*. Also, the presence of a fugacious veil included in Patouillard's description recalls that of *L. boryana*. No explicit designation of a holotype was indicated in the protologue for the name *A. umbilicata*, and there is a need for lectotypification because

Pegler (1983a) only referred to this collection as the "type". We consider *A. umblicata* to be a taxonomic synonym of *A. boryanus*.

Gymnopus alliaceus Murrill. 1943. Mycologia 35: 425.

HOLOTYPE: U.S.A., Florida, Magnesia Springs, 15.VIII.1938, coll. W.A. Murrill, F 17940, FLAS [!]

Basidiomata ten, in fair condition. Some basidiomata partially eaten by insects, some with eroded pileus surface. **Pileus** now 30-60 mm diam, broadly convex, $\pm$ depressed, glabrous (now wrinkled); margin curved to incurved. **Lamellae** seceding, close to $\pm$ crowded, narrow, beige to brown; margin entire. **Stipe** central, equal to $\pm$ broad at apex, striate to sulcate.

Pileipellis a repent layer of interwoven filamentous hyphae, worn off in most basidiomata; hyphae 3-8 μ m diam, hyaline singly, light brown in mass, with clamp connections; wall thin. **Pileus trama** interwoven; hyphae 6-18 μ m diam, with clamp connections; wall up to 2.4 μ m thick. Oleiferous hyphae embedded in pileus trama. **Lamellar trama** parallel; hyphae 4-14 μ m diam, hyaline, with clamp connections; wall up to 1.6 μ m thick. **Basidia** 17-18 X 4-5 μ m, clavate; sterigmata 4. **Pleurocystidia** not observed. **Cheilocystidia** (Fig. 5a) 12-24 X 4-5 μ m, mostly clavate, some flexed; apex obtuse or knobbed; uncommon. Lamella edge fertile. **Stipe trama** parallel; hyphae 5-12 μ m diam, with clamp connections; wall 0.8-3.2 μ m thick. **Caulocystidia** not observed. **Basidiospores** (Fig. 5b) 5.6-6.4 X 2.4-3.2 μ m, ($n = 20$, $x = 6.0$ X 2.8 μ m, $Q = 1.75$ -2.67, $Qx = 2.19$), narrowly ellipsoid, hyaline, inamyloid; wall thin, smooth.

Comment: All the observed microscopic characters in *G. alliaceus* are similar to those of the type specimen of *A. raphanica*. Basidiospore measurements of 5-6 x 4 μ m, recorded by Murrill (1943), fall into the range reported here. Cheilocystidia are similar to those found in *A. raphanica*. Murrill (1943) did not observe any cystidia, a hint that these are not readily distinguishable from other hymenial elements. The onion-like odor reported by Murrill (1943), however, resembles that of *A. raphanica*, and has been noted in some of our field collections.

We consider *G. alliaceus* as a taxonomic synonym under *A. raphanica*. Basidiomata of both type specimens exhibit the same combination of macroscopic and microscopic characters. The ICBN directs us to choose between simultaneously published, taxonomically indistinguishable names, and we have done so.

Lentinus cubensis Berkeley & Curtis. 1869. J. Linn. Soc., Bot. 10: 302.

LECTOTYPE [*hic designatus*]: Cuba, coll. C. Wright, no. 115, K [!]

$\equiv$ *Lentinula cubensis* (Berk. & Curt.) Earle. 1909. Bull. New York Bot. Gard. 5: 416.

Basidiomata two, moldy; one is pressed flat. **Pileus** 12-24 mm diam, circular, probably convex; surface $\pm$ smooth, yellow brown (5C7, 5E8); margin slightly incurved. **Lamellae** adnate, seceding, forming a "pseudo-collarium", close, pale orangeyish (5A4) where not covered by mold; margin entire or eroded; lamellulae in at least two tiers.

Stipe 12-15 X 1-2 mm, central to slightly eccentric, $\pm$ widened at apex and base, appearing sulcate, fibrillose to $\pm$ scaly. No veil or annulus observed.

Pileipellis a repent layer of compacted, interwoven hyphae, embedded in a $\pm$ gelatinous matrix; hyphae 2-6 μ m diam, hyaline singly, yellow-brown in mass, with clamp connections; wall thin. **Pileus trama** loosely interwoven; hyphae 6-16 μ m diam, hyaline, with clamp connections; wall 1-3 μ m thick. **Lamellar trama** parallel at first, becoming irregular to interwoven at lamellar edge; hyphae 4-10 μ m diam, with clamp connections; wall 2-4 μ m thick. Subhymenium poorly developed. Hymenium composed of two elements: 1) **basidia** 12-19 x 4-7 μ m, clavate; sterigmata 1-4, most with only two visible sterigmata; and 2) **basidioles** numerous, equal in size to basidia, clavate or ampullaceous. **Pleurocystidia** none. **Cheilocystidia** (Fig. 6a) 16-30 x 5-14 μ m, clavate to broadly clavate, or sphaeropedunculate, mostly collapsed. **Stipe trama** parallel; hyphae 2-7 μ m diam, hyaline singly, straw color in mass, with clamp connections; wall up to 1.5 μ m thick. **Caulocystidia** (Fig. 6b) 12-32 x 5-12 μ m, cylindrical to broadly clavate, with obtuse or mucronate apex. **Basidiospores** (Fig. 6c) 4.8-6.0 x 2.4-3.2 μ m ($n = 40$, $x = 5.5$ X 2.9 μ m, $Q = 1.71$ -2.33, $Qx = 1.95$), ellipsoid, subovoid, hyaline; wall smooth, thin.

Comment: Earle (1909) proposed *Lentinula* as a new genus and designated *L. cubensis* as its type species, but *A. boryanus* is an earlier epithet for the species (see Singer, 1955). Unlike Horak (1968), we found basidiospores on a paradermal section of the pileus, the spore ranges and averages being similar to those observed in *A. boryanus*. Cheilocystidia match those of the type of *A. boryanus*, although some cheilocystidia present outgrowths which are not uncommon in more recent collections of *L. boryana*.

There is no explicit designation of a lectotype specimen for *L. cubensis* in previous studies, and collection Wright no. 115 is cited as the "K type" in the two of the three keystone works for *L. boryana* (Pegler, 1975, 1983a, b). It is the intention here to resolve this situation by explicitly designating Wright no. 115 as the lectotype specimen of *L. cubensis*. Microscopic examination of paratype specimens Wright no. 80, 121, 122 (FH) confirmed their identity as *L. cubensis*. Like previous workers (Pegler 1975, 1983a, b; Singer, 1952, 1955) we consider *L. cubensis* to be a taxonomic synonym of *A. boryanus*.

Lentinus detonsus Fries. 1851. Nov. Symb. Mycol., p. 38.

HOLOTYPE: Costa Rica, Oersted, missing. **NEOTYPE** [*hic designatus*]: Costa Rica, Prov. San José, Jardín de Dota, 3.5 km W. of Inter-American Highway at El Empalme, 9° 42' 52" N, 83° 58' 28" W, elev. 2220 m, 16.VI.1995, coll. R.E. Halling, field no. 7814 (TENN 53824) [!]

$\equiv$ *Lentinula detonsa* (Fr.) Murrill. 1911. Mycologia 3:28.

Basidioma one, air-dried, in good condition. **Pileus** convex when young, in age lobate to depressed, disc "avellanus" to "tilleul buff" (7B3 - 7B2). **Lamellae** subventricose, free, close, off-white to "tilleul buff" (7B2); margin entire. **Stipe** somewhat bulbous at

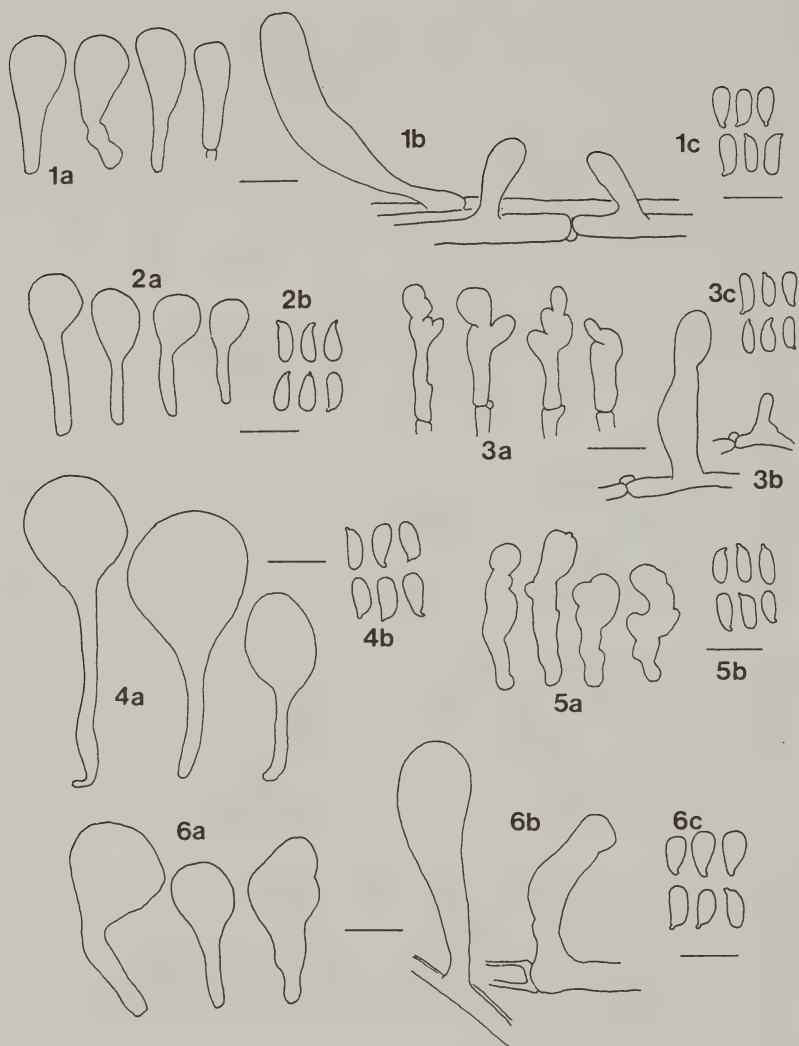


Fig. 1. *A. boryanus*. a) cheilocystidia, b) caulocystidia, c) spores. Scale bar = 10 μm.

Fig. 2. *A. ixodes*. a) cheilocystidia, b) spores. Scale bar = 10 μm.

Fig. 3. *A. raphanica*. a) cheilocystidia, b) caulocystidia, c) spores. Scale bar = 10 μm.

Fig. 4. *A. umbilicata*. a) cheilocystidia, b) spores. Scale bar = 10 μm.

Fig. 5. *G. alliaceus*. a) cheilocystidia, b) spores. Scale bar = 10 μm.

Fig. 6. *L. cubensis*. a) cheilocystidia, b) caulocystidia, c) spores. Scale bar = 10 μm.

base, scrobiculate, concolorous with gills, at base "army brown" to "natal brown" (8D5 - 8E6); flesh white; consistency tough; veil apparently absent. Odor of cut lamellae very fungus-like, taste not acrid.

Pileipellis a layer of repent, tightly interwoven hyphae; hyphae 2-8 μm diam, pigmented light brown, with clamp connections; wall thin. **Pileus trama** loosely interwoven; hyphae 6-16 μm diam, constricted at septa, with clamp connections; wall 2-4 μm thick. **Lamellar trama** regular to subregular; hyphae 3-7 μm diam; walls up to 1 μm thick. **Basidia** 21-26 X 6-7 μm , clavate; sterigmata 4. **Pleurocystidia** not observed. **Cheilocystidia** (Fig. 7a) 25-36 X 10-14 μm , clavate, broadly clavate to sphaeropedunculate, with clamp connections; apex obtuse or irregularly lobed. **Stipe trama** parallel; hyphae 3-6 μm diam, with clamp connections; walls up to 1.5 μm thick. **Caulocystidia** (Fig. 7b) 20-25 X 5-8 μm , clavate, uncommon to rare; apex obtuse or irregularly lobed. **Basidiospores** (Fig. 7c) 6.0-8.0 X 3.2-4.0 μm ($n = 20$, $x = 7.0$ X 3.4 μm ; $Q = 1.78$ -2.25, $Qx = 2.06$), ellipsoid, ovoid, hyaline, inamyloid; wall thin, smooth.

Comment: An Oersted specimen under *Lentinus detonsus* is not resident at UPS (herb. Fries) or C (herb. Oersted). With no holotype or lectotype material available, we are obliged to neotypify the name in order to secure its identity. The neotype is from the same country of origin (Costa Rica), exhibits the morphological characters of *L. boryana*, and therefore serves to tie more firmly the name *L. detonsus* and *L. boryana* as listed by Pegler (1983a). Cystidia and basidiospores found in this neotype are typical for *L. boryana*. The name *Lentinula detonsa* has been misapplied to taxa collected along the Gulf Coast of the U.S.A. (Metzler and Metzler, 1992), which actually correspond to *A. raphanica*.

Lentinus proximus Berkeley & Curtis. 1869. J. Linn. Soc., Bot. 10:302.

LECTOTYPE [*hic designatus*]: Cuba, C. Wright, no. 117, FH [!].

Basidiomata two, moldy, lamellae partially eaten by insects. **Pileus** convex; surface $\pm$ smooth to fibrillose; margin inrolled. **Lamellae** adnate-seceding, forming a "pseudo-collarium", close, $\pm$ broad; margin entire or eroded; lamellulae in two tiers. **Stipe** central; $\pm$ widened at base, appearing sulcate, fibrillose. No evidence of veil or annulus.

Pileipellis a compact, repent layer of interwoven hyphae; hyphae 3-6 μm diam, hyaline singly, light brown in mass, with clamp connections; wall thin. **Pileus trama** loosely interwoven; hyphae 6-14 μm diam, hyaline, with clamp connections; wall 1-3 μm thick. **Lamellar trama** parallel; hyphae 4-12 μm diam, with clamp connections; wall 0.5-2 μm thick. Subhymenium poorly developed. **Basidia** 14-18 X 4-7 μm , clavate, often collapsed; sterigmata 1-4, often only two visible. **Pleurocystidia** not observed. **Cheilocystidia** (Fig. 8a) 12-33 X 5-12 μm , clavate to broadly clavate, often collapsed; apex obtuse, or irregularly lobed to branched. **Stipe trama** parallel; hyphae 2-10 μm diam, hyaline singly, straw colored in mass, with clamp connections; wall 0.8-2.4 μm thick. **Caulocystidia** not observed. **Basidiospores** (Fig. 8b) 5.6-7.2 X 2.4-3.2 μm , ($n = 20$, $x = 6.4$ X 2.9 μm , $Q = 2.0$ -2.67, $Qx = 2.19$), ellipsoid, subovoid to subcylindrical, hyaline, inamyloid; wall thin, smooth.

Comment: All micromorphological characters conform to those described for *A. boryanus* (see above). The stipes of the basidiomata are very contaminated with mold and confirmation of caulocystidia was not possible. Previous workers did not expressly designate a lectotype for *L. proximus* (Pegler, 1975, 1983a), and now we propose collection Wright no. 117 to serve this function. We consider *L. proximus* to be a taxonomic synonym of *A. boryanus*.

Lentinus puiggarii Spegazzini. 1919. Bol. Acad. Nac. Cienc. Córdoba 23: 387.

HOLOTYPE: Brazil, Apiahy, L. Puiggari, no. 86, LPS [!].

Basidiomata five, all in very deteriorated and moldy condition, broken or worn off, some eaten by insects. **Pileus** 5-15 mm diam; surface glabrous, brownish with olive-gray hues. **Lamellae** seceding, close, somewhat narrow, brown; margin eroded in most basidiomata. **Stipe** central, striate-sulcate, somewhat wider at base, light brown; consistency tough. On wood.

Pilepellis a repent layer of tightly interwoven filamentous hyphae; hyphae 3-6 μm diam, hyaline singly, light brown in mass, with clamp connections; wall thin. **Pileus trama** $\pm$ loosely interwoven; hyphae 4-10 μm diam, hyaline, with clamp connections; wall 0.8-2.4 μm thick. **Lamellar trama** regular; hyphae 4-12 μm diam, hyaline, with clamp connections. Hymenium 12-20 μm thick; basidia indistinguishable from basidioles; sterigmata collapsed. **Pleurocystidia** not observed. **Cheilocystidia** (Fig. 9a) 19-32 X 4-8 μm , clavate to broadly clavate or sphaeropedunculate, often collapsed. **Stipe trama** parallel; hyphae 4-12 μm diam, hyaline singly, yellowish in mass, with clamp connections; wall 0.8-2.4 μm thick. **Caulocystidia** (Fig. 9b) 21-25 X 4-8 μm , cylindrical to clavate, flexous. **Basidiospores**: (Fig. 9c) 4.4-5.6 X 2.0-2.8 μm ($n = 14$, 5.1 X 2.4 μm , $Q_x = 1.71$ -2.80, $Q = 2.16$), lacrymoid in side view, ellipsoid to subovoid in profile, collapsed, hyaline, inamyloid; wall thin, smooth.

Comment: On the original voucher folder there are drawings of five basidiospores, 6 X 3 μm , ellipsoid in profile. Singer (1952) provided descriptions of what he considered *L. puiggarii* from fresh material, the basidiospores measuring 5-7.3 X 2.8-4.3 μm , but gave no report of cystidia. However, Singer (1952) thought this species to be related to the types of *A. ixodes* and *L. cubensis*, both synonyms of *A. boryanus*. In our view, cheilocystidia, caulocystidia and basidiospore dimensions match those found on the type specimen of *A. boryanus*.

Panus leprieurii Montagne 1854. Ann. Sci. Nat., Bot. Ser. 4, 1:121 [*non Lentinus leprieurii* Mont. 1854]

LECTOTYPE [*hic designatus*]: Guyana, Cayenne, Leprieur, no. 980, K [!]

Basidioma one, pressed flat, glued to cardboard, severely covered by mold, broken at stipe. **Pileus** about 6 mm diam, probably convex, color not detectable, margin inrolled. **Lamellae** seceding, close, narrow, margin brown to hazel brown, apparently smooth. **Stipe** nearly central, short, striated longitudinally. On wood.

Pileipellis a simple cutis; hyphae 2-4 μm diam, filamentous, radially oriented, somewhat gelatinized, hyaline singly, light brown in mass, with clamp connections; wall thin. **Pileus trama** interwoven; hyphae 3-11 μm diam, hyaline singly, yellowish in mass, with clamp connections; wall thin. **Lamellar trama** subregular; hyphae 2-8 μm diam, hyaline, with clamp connections; wall thin. Hymenium composed of two elements: 1) **basidia** 15-21 X 5-7 μm , clavate, hyaline; wall thin; sterigmata 4; and 2) **basidioles** similarly sized, clavate to mucronate. **Pleurocystidia** not observed. **Cheilocystidia** (Fig. 10a) 18-27 X 5-8 μm , mostly clavate, few sphaeropedunculate, some knobbed; apex obtuse, hyaline; wall thin. **Stipe epicutis** parallel; hyphae 3-8 μm diam, hyaline singly, yellowish in mass, with clamp connections; wall thin to 1.6 μm thick. **Caulocystidia** not observed. **Basidiospores** (Fig. 10b) 5.2-7.2 X 2.8-3.6 μm ($n = 27$, $x = 6.0$ X 3.0 μm ; $Q = 1.75$ -2.29, $Qx = 1.98$), pip-shaped in side view, ellipsoid to subcylindrical in profile, hyaline; wall thin, smooth.

Comment: The protologue description by Montagne (1854) of the type specimen coincides with habit and stature of modern day *L. boryana*. Montagne (1854) noticed a veil, scales on the pileus, tough consistency, and seceding lamellae typical of *Lentinula*. Cheilocystidia are not readily distinguished in size from basidioles, but distinct by their shape, but are similar to the cheilocystidia of the type specimen of *A. boryanus*. Heavy mold infestation made detection of caulocystidia impossible. Pileus epicutis gelatinization is similar to that observed in other type specimens under *A. boryanus*.

Collection Leprieur no. 980 is designated here as the explicit lectotype of *P. leprieurii*. The basidiome represents a younger stage of the paratype collection Leprieur no. 981, which we also have examined.

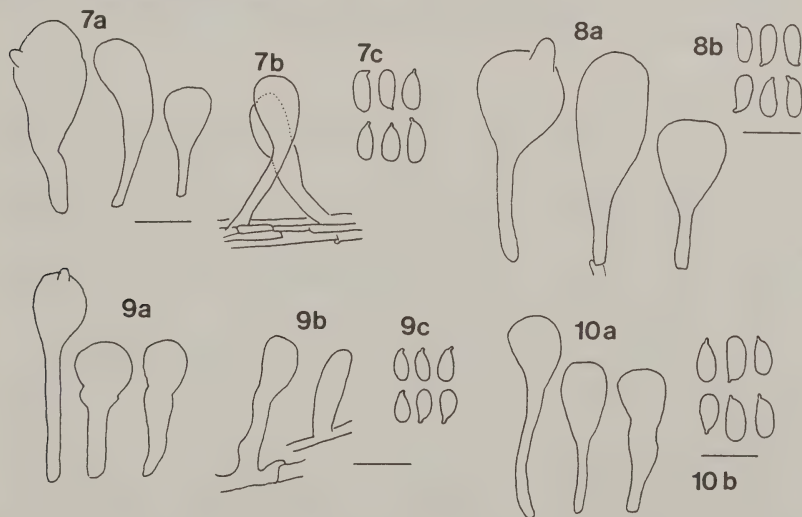


Fig. 7. *L. detonsus*. a) cheilocystidia, b) caulocystidia, c) spores. Scale bar = 10 μm .

Fig. 8. *L. proximus*. a) cheilocystidia, b) spores. Scale bar = 10 μm .

Fig. 9. *L. puiggarii*. a) cheilocystidia, b) caulocystidia, c) spores. Scale bar = 10 μm .

Fig. 10. *P. leprieurii*. a) cheilocystidia, b) spores. Scale bar = 10 μm .

SUMMARIZED NOMENCLATORS (for detailed nomenclators see above)

Lentinula boryana (Berk. & Mont.) Pegler. 1975. *Kavaka* 3:19.

= *Agaricus boryanus* Berkeley & Montagne. 1849. *Ann. Sci. Nat., Bot. Ser.* 3, 11: 325

= *Lentinus detonsus* Fries. 1851. *Nov. Symb. Mycol.* [Saccardo 5:597]

= *Panus leprieurii* Montagne. 1854. *Ann. Sci. Nat., Bot. Ser.* 4, 1: 121 [*non Lentinus leprieurii* Mont. 1854]

= *Agaricus ixodes* Montagne. 1854. *Ann. Sci. Nat., Bot. Ser.* 4, 1: 95.

= *Lentinus cubensis* Berkeley & Curtis. 1869. *J. Linn. Soc., Bot.* 10: 302.

= *Lentinus proximus* Berkeley & Curtis. 1869. *J. Linn. Soc., Bot.* 10:302.

= *Armiliariella umbilicata* Patouillard. 1899. *Bull. Soc. Mycol. France.* 15: 191.

= *Lentinus puiggarii* Spegazzini. 1919. *Bol. Acad. Nac. Cienc. Córdoba* 23: 387.

Lentinula raphanica (Murrill) Mata & R.H. Petersen *comb. nov.*

= *Armillaria raphanica* Murrill. 1943. *Mycologia* 35: 35:422.

= *Gymnopus alliaceus* Murrill. 1943. *Mycologia* 35: 425.

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We thank the mycology curators at the following institutions for arranging herbarium loans of pertinent specimens: Harvard University (Dr. Donald Pfister), Royal Botanic Gardens, Kew (Dr. David N. Pegler, Dr. B. Spooner), University of Florida (Dr. James Kimbrough), New York Botanical Garden (Dr. Roy E. Halling), Herbario del Instituto de Botánica Carlos Spegazzini (Dr. Arambari), and Laboratoire de Cryptogamie, Paris (Dr. Bart Buyck). We also thank Dr. Tim Baroni for reviewing this manuscript. This research was partially funded by NSF DEB 9521526 (PEET program).

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DOASSANSIOPSIS EURYALIS SP. NOV. (USTILAGINOMYCETES)

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Key words: smut fungi, *Euryale ferox*, India.

ABSTRACT

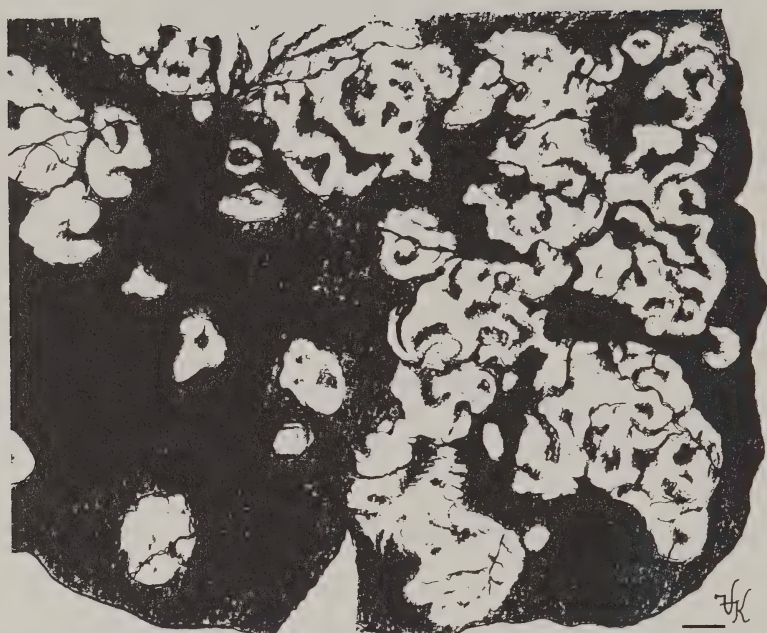
A new smut fungus, *Doassansiopsis euryalis* is described and illustrated on the cultivated *Euryale ferox* from India.

Euryale ferox Salisb. (Nymphaeaceae), a spiny water plant, is cultivated on commercial scale in China and India for its edible seeds rich in starch. In India, it is parasitised by a fungus, producing golden-yellow coloured, irregular, cerebriform swellings on the leaves. The study of a diseased leaf, preserved in IMI, revealed that the parasite is an unknown smut fungus:

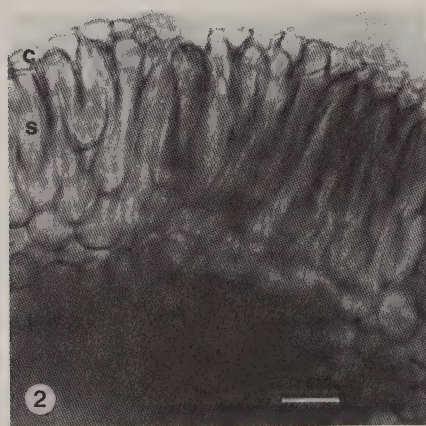
Doassansiopsis euryalis Vánky, sp. nov.

Typus in matrice *Euryale ferox* Salisb., India, North Bihar, sine loco et die, comm. V. Jha, Sept. 1989. Holotypus in IMI 335137, isotypus in Herbario Ustil. Vánky, HUV 19510.

Sori in foliis hypertrophyam bullatam, irregulariter cerebriformem et deformationem, 0,5–5 cm. diametro, vel illas confluentes majores producentes et idonei occupationis areas magnas, venis non limitatas, aureoflavas superficiei foliorum, cum glomerulis sporarum in telis hospitis immersis. Venae folii soris inclusae sicut lineae carminorubrae conspicuae. *Glomeruli sporarum* globosi, ovoidei, ellipsoidales vel parum irregulares, 80–170 x 100–230 µm, pallide flavidobrunnei, compositi e massa centrali parenchymatica telae fungalis, circumdata strato sporarum elongatarum et strato externo, corticali cellularum parvarum sterilium. *Sporae* radialiter elongatae, parum irregulares, lateraliter



1



2

Fig. 1 A leaf segment of *Euryale ferox* with bullate, irregular, cerebriform, hypertrophied sori of *Doassansiopsis euryalis* Vánky (type). Bar = 1 cm.

Fig. 2 Part of a spore ball of *Doassansiopsis euryalis* with a thin cortical layer of small, sterile cells (c), radially elongated spores (s), and a central mass of parenchymatous fungal tissue of empty cells (p). Hand-cut section embedded in lactophenol with cotton blue (type). Bar = 10 μ m.

compressae, raro subcuneiformes, 5,5–10,5 x 16–30 μm , pallide flavae, infra corticem, subpolyedrice irregulari, 5,5–10,5 x 6,5–12 μm ; pariete aequaliter crasso, cca. 0,5 μm , levi. *Cellulae steriles centrales* subglobosae, ovoideae, ellipsoidales usque parum irregulares, lateribus compressis, magnitudine variae, 5,5–10,5 x 5,5–12 μm , hyalinae vel pallide flavae, vacuae; pariete tenui, aequali, cca. 0,5 μm , levi. *Cellulae steriles corticales* plerumque tangentialiter deplanatae, quadrangulares vel subcuneiformes, radialiter 3–5,5 μm latae, si subcuneiformes usque ad 8 μm longae, tangentialiter 4–8 μm longae; pariete tenui, aequali, cca. 0,5 μm , levi.

Sori (Fig. 1) in the leaves producing bullate, irregularly cerebriform hypertrophy and deformation, 0.5–5 cm in diameter or larger by confluence and may cover large areas of the leaf surface, not delimited by the veins, golden-yellow coloured, with spore balls embedded in the host tissue. The leaf veins within the sori appear as carmine-red lines. *Spore balls* globose, ovoid, ellipsoidal or slightly irregular, 80–170 x 100–230 μm , pale yellowish-brown, composed of a central mass of parenchymatous fungal tissue surrounded by a layer of elongated spores and an outer, cortical layer of small, sterile cells. *Spores* (Fig. 2, "s") radially elongated, slightly irregular, laterally compressed, rarely subcuneiform, 5.5–10.5 x 16–30 μm , pale yellow, the distal side, beneath the cortex, is subpolyhedrally irregular, 5.5–10.5 x 6.5–12 μm ; wall evenly thick, c. 0.5 μm , smooth. *Central sterile cells* (Fig. 2, "p") subglobose, ovoid, ellipsoidal to slightly irregular with compressed sides, variable in size, 5.5–10.5 x 5.5–12 μm , hyaline or pale yellow, empty; wall thin, even, c. 0.5 μm , smooth. *Cortical sterile cells* (Fig. 2, "c") usually tangentially flattened, quadrangular or subcuneiform, radially 3–5.5 μm wide, when subcuneiform up to 8 μm long, tangentially 4–8 μm long; wall thin, even, c. 0.5 μm , smooth.

On Nymphaeaceae: *Euryale ferox* Salisb.; N.E. India. Known only from the type collection.

Beside the host plant and the strongly hypertrophied, cerebriform, golden-yellow sori, *Doassansiopsis euryalis* has very typical long and narrow spores. Of the nine known *Doassansiopsis* species two are on members of Nymphaeaceae: *D. nymphaeae* (H. & P. Sydow) Thirum., type on *Nymphaea stellata* Willd., India, and *D. ticonis* M. Piepenbr., type on *Nymphaea blanda* G. F. W. Meyer, Costa Rica. The spores of *D. nymphaeae* are 13–16 μm long, those of *D. ticonis* 12–16 μm long.

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PHYLOGENETIC RELATIONSHIPS OF *ASTERODON* AND *ASTEROSTROMA* (BASIDIOMYCETES), TWO GENERA WITH ASTEROSETAE

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Abstract

The occurrence of asterosetae in *Asterodon* and *Asterostroma* suggests a close relationship of these genera, whereas other morphological and anatomical features point at a polyphyletic origin. Using a dataset of 26 taxa, the relationships and the assignments of *Asterodon* and *Asterostroma* are studied by molecular sequence data of a region of the large subunit of the nuclear encoded ribosomal DNA. Taxon sampling includes representatives of the Hymenochaetales, the Lachnocladiales, the Russulales and the Polyporales. According to the phylogenetic analysis, *Asterodon* and *Asterostroma* are not closely related. *Asterodon* is evidently placed within the Hymenochaetales. A sister group to this genus was not found with confidence within the hymenochaetoid taxa included in this study. *Asterostroma* is placed in the Lachnocladiales, close to *Vararia* and *Dichostereum*. The two evolutionary lineages, *Asterodon* and *Asterostroma*, in which asterosetae convergently occur, are discussed referring to morphological and anatomical characteristics.

Key words: molecular systematics, ribosomal DNA, Hymenochaetales, Lachnocladiales

Introduction

The two aphyllophoroid genera *Asterodon* Pat. and *Asterostroma* Masee, both exhibit a significantly ramified structure (Figs. 1, 2), the asteroseta (Corner, 1948; Parmasto, 1970; Jülich, 1984; Hallenberg & Eriksson, 1985; Boidin et al., 1997). The unique shape of these eponymous setae implies a homologous development and a close relationship (Patouillard, 1900; Bourdot & Galzin, 1928; Donk, 1933).

Asterodon ferruginosus, the single species of the genus, is quite rare to find, and the distribution is restricted to Northern Europe (Sweden, Norway, Finland), France, Siberia, Asian Far East and Northern America (Corner, 1948; Parmasto, 1970; Jülich, 1984). The species grows on rotten coniferous trees and less often on angiosperms. The basidiocarps are resupinate, felted-membraneous and produce a hydroid hymenophore. Basidiospores are hyaline, smooth and ellipsoid, the hyphal system is dimitic. Asterosetae sometimes are regarded as another type of hyphae and thus the hyphal system of *Asterodon* is described as trimitic (Parmasto 1970; Hallenberg &

Eriksson 1985); Parmasto (1970) creates the terms asterodimitic and asterotrimitic. Several characteristics, such as the xanthochroic reaction, the cause of a white rot, the yellow to deep brown trama, the clampless hyphae and the hymenial setae (Fig. 3), indicate a taxonomic position within the Hymenochaetales Donk (Hymenochaetales Oberwinkler; Corner, 1948; Parmasto, 1970; Oberwinkler, 1977; Fiasson & Niemelä, 1984; Jülich, 1984; Hansen & Knudsen, 1997). Another important taxonomic hint are the imperforated septal pore caps (Müller et al., 2000), which are assumed as characteristic within the Hymenochaetales (Moore, 1980; Keller, 1997). As next relatives within the Hymenochaetales the hydroid genus *Hydnochaete* Bres. and the corticioid genus *Hymenochaete* Lév. are regarded (Ryvarden, 1982).

The approximately 20 species of the genus *Asterostroma* are mostly tropical. The corticioid basidiocarps are resupinate and membranous. Based on characteristics of the basidiospores, the genus is divided in the two subgenera *Austroasterostroma* Parm. (basidiospores not amyloid and smooth) and *Asterostroma* (basidiospores amyloid and smooth or tuberculate) and the latter into the two sections *Laevispora* Parm. (basidiospores smooth) and *Asterostroma* (basidiospores tuberculate; Parmasto, 1970). The hyphal system is monomitic (asterodimitic), built up by clampless and hyaline generative hyphae. But the character of the hyphal system does not seem to be homogeneous within *Asterostroma*, because the existence of dimitic (asterotrimitic) species is mentioned (Parmasto, 1970; Hallenberg & Eriksson, 1985; Boidin, 1997).

The taxonomic position of *Asterostroma* is still controversial. The occurrence of asterosetae suggests a close affinity with the Hymenochaetales (Jülich, 1984) respectively Hymenochaetales (Hawksworth et al., 1995), but the perforated septal pore caps (Müller et al., 2000) are untypical. The occurrence of thin-walled cystidia in the hymenium, which seem to be homologous to the gloecystidia of *Lachnocladium* Lév., indicates a close relationship to the Lachnocladiaceae Reid (Lachnocladiales Jülich; Corner, 1948; Reid, 1965; Parmasto, 1970; Oberwinkler, 1977; Hansen & Knudsen, 1997). The asterosetae of *Asterostroma* can be regarded as a transition to the dichohyphidia of *Vararia* P. Karst. (Corner 1948). Based on the occurrence of dichohyphidia within tropical species of *Hymenochaete*, Corner (1948) assumes this genus as possibly the critical group for the explanation of an affinity of *Asterodon*, *Asterostroma* and *Vararia*. Referring to the common occurrence of gloecystidia and tuberculate basidiospores, Oberwinkler (1977) suggests a close relationship of *Asterostroma*, the Lachnocladiaceae and the aphyllophoralean Russulales Sing.

Comparing all the data at hand a close relationship between *Asterodon* and *Asterostroma* is unlikely. The taxonomic position of the two genera, predominately with regard to the natural groupings within the Hymenochaetales (Murrill, 1904, 1905, 1907; Donk, 1969; Fiasson & Niemelä, 1984; Dai, 1995, 1999; Fischer, 1996; Niemelä et al. 2001; Wagner & Fischer, 2001) was not yet extensively discussed.

This study aims to evaluate the significance of morphological and anatomical characters mentioned above, compared with a phylogenetic analysis of nuc-18S sequencing data for a selected range of taxa. Taxon sampling included representatives of *Asterodon* and *Asterostroma* sect. *Asterostroma*, of the Hymenochaetales, the Lachnocladiales, the Russulales and the Polyporales (Herter) Gäum. (Tab. 1).

Within the Hymenochaetales poroid species were chosen, to represent major subgroups within *Phellinus* s. l. Quél. (*Phellinus* s. str., *Fomitiporia* Murrill, *Fuscoporia* Murrill, *Phellinidium* Fiasson & Niemelä, *Phellopilus* Niemelä, Wagner & Fischer, *Porodaedalea* Murrill, *Phylloporia* Murrill) and *Inonotus* s. l. P. Karst. (*Inonotus* s. str., *Inocutis* Fiasson & Niemelä, *Inonotopsis* Parm., *Onnia* P. Karst.), furthermore the genus *Coltricia* S.F. Gray. Additional species from the corticioid genus *Hymenochaete* and from the irpicoid genus *Hydnochaete* were included. *Dichostereum* Pilát and *Vararia* species represent the corticioid Lachnocladales. The Russulales are represented by the poroid *Bondarzewia montana* (Quél.) Singer and agaricoid *Russula violacea* Quél. From the Polyporales *Fomes fomentarius* (L.: Fr.) Fr. and *Fomitopsis pinicola* (Sw.: Fr.) P. Karst. were chosen. *Tremella foliacea* (Pers.: S.F. Gray) Pers. (Heterobasidiomycetes) was selected as an outgroup. For the 26 species a part of the nuclear large subunit of the ribosomal DNA (nLSU rDNA) was sequenced (24 species), respectively sequences were obtained from GenBank (2 species; see Tab. 1).

Material and Methods

Table 1. List of taxa, included in the phylogenetic analysis; source of fungal material (HB: Helmut Besl, YCD: Yu-Cheng Dai, MF: Michael Fischer, TN: Tuomo Niemelä, TW: Tobias Wagner, REG: Herbarium of the University of Regensburg) and sequence data base accession number.

Species	Origin of stocks (stock number)	Substrate	Accession number
<i>Asterodon ferruginosus</i> Pat.	Finland (YCD 3186) REG	on fallen trunk of <i>Pinus sylvestris</i> .	AF323735
<i>Asterostroma medium</i> Bres.	Germany (CBS 119.50)	unknown	AF323736
<i>Asterostroma ochroleucum</i> Bres.	Germany (HB 9/89) REG	on dead wood	AF323737
<i>Coltricia perennis</i> (L.: Fr.) Murrill	Germany (MF 92-96) REG	on ground under <i>Pinus sylvestris</i> dead stump of <i>Carpinus spec.</i>	AF311004
<i>Dichostereum durum</i> (Bourd. & Galz.) Pilát	France (CBS 707.81)	<i>Betula nigra</i>	AF323738
<i>Dichostereum effuscatum</i> (Cooke & Ellis) Boidin & Lanquetin	USA (CBS 516.80)		AF323739
<i>Fomes fomentarius</i> (L.: Fr.) Fr.	Germany (TW 85) REG	<i>Fagus sylvatica</i>	AF311047
<i>Fomitiporia punctata</i> (P. Karst.) Murrill (= <i>Phellinus punctatus</i> (Fr.) Pilát)	Germany (MF 85-74) REG	<i>Corylus avellana</i>	AF311007
<i>Fomitopsis pinicola</i> (Sw.: Fr.) P. Karst.	Germany (TW 321) REG	<i>Betula</i>	AF311048
<i>Fuscoporia ferruginosa</i> (Schrad.: Fr.) Murrill (= <i>Phellinus ferruginosus</i> (Schrad.: Fr.) Pat.)	Germany (MF 82-930) REG	<i>Fagus sylvatica</i>	AF311032
<i>Hydnochaete dupontii</i> Pat.	France; La Réunion (CBS 941.96)	<i>Casuarina equisetifolia</i>	AF323740
<i>Hymenochaete rubiginosa</i> (Dicks.: Fries) Lévy.	Germany (TW 22.9.97) REG	on dead <i>Quercus spec.</i>	AF323741
<i>Inocutis rheades</i> (Pers.) Fiasson & Niemelä (= <i>Inonotus rheades</i> (Pers.) Bond. & Sing.)	Germany (TW 385) REG	<i>Populus tremula</i>	AF311019
<i>Inonotopsis subiculosa</i> (Peck) Parm. (= <i>Inonotus subiculosus</i> (Peck) J. Erikss. & Strid)	China (YCD 2203) REG	<i>Abies alba</i>	AF311020
<i>Inonotus hispidus</i> (Bull.: Fr.) P. Karst.	Germany (MF 92-829) REG	<i>Fraxinus excelsior</i>	AF311014
<i>Onnia triquetra</i> (Fr.) Imazeki (= <i>Inonotus triqueter</i> (Fr.) P. Karst.)	Germany (TW 411) REG	<i>Pinus sylvestris</i>	AF311024

<i>Phellinidium ferrugineofuscum</i> (P. Karst.) Fiasson & Niemelä (= <i>Phellinus ferrugineofuscum</i> (P. Karst.) Bourd. & Galz.)	Finland (TN 6121) REG	<i>Picea abies</i>	AF311031
<i>Phellinus igniarius</i> (L.: Fr.) Quél.	Germany (MF 83-1110a) REG	<i>Salix fragilis</i>	AF311033
<i>Phellogilus nigrolimitatus</i> (Romell) Niemelä, Wagner & Fischer (= <i>Phellinus nigrolimitatus</i> (Romell) Bourd. & Galz.)	Germany (MF 85-823) REG	<i>Larix decidua</i>	AF311036
<i>Phylloporia ribis</i> (Schumach.: Fr.) Ryvarden (= <i>Phellinus ribis</i> (Schum.: Fr.) P. Karst.)	Germany (MF 82-828) REG	<i>Ribes uva-crispa</i>	AF311040
<i>Porodaedalea pini</i> (Brot.: Fr.) Murrill (= <i>Phellinus pini</i> (Brot.: Fr.) Ames)	France (TW 11.4.97) REG	dead wood of <i>Pinus</i> spec.	AF311037
<i>Tremella foliacea</i> (Pers.: S.F. Gray) Pers.	Germany (MF 97-1117) REG	deciduous wood	AF311051
<i>Vararia gallica</i> (Bourd. & Galz.) Boidin	France (CBS 656.81)	unknown	AF323742
<i>Vararia ochroleuca</i> (Bourd. & Galz.) Donk	France; Drôme (CBS 465.61)	litter of <i>Quercus</i> spec. and <i>Juniperus</i> spec.	AF323743
GenBank: <i>Russula violacea</i> Quél.			AF218559
<i>Bondarzewia montana</i> (Quél.) Sing.			AF042646

Scanning electron microscopy

Small sections from context and hymenium of herbarized fruiting bodies were fixed on metal stubs. The samples were coated with a 1.4 nm gold-palladium layer in a Polaron SEM SC 515 Sputter Coater. Microscopy and photography were done with a Digital Scanning Microscope DSM (Zeiss).

DNA isolation

DNA was isolated from cultured mycelia or herbarium specimens. Cultures were grown on 2% malt extract agar, ME (2% malt extract, 2% agar, 0.05% yeast extract in distilled water) at 23°C. Total DNA was isolated as described by Lee & Taylor (1990). DNA pellets were air-dried and were resuspended in 100 µL TE buffer (10 mM Tris HCl, 1 mM EDTA, pH 8.0). Quantity and quality of DNA were examined on 1% agarose gels (Biorad).

PCR amplification and DNA sequencing

DNA usually was diluted 1:1000 in distilled water. Approximately 1400 bases (b) of the nLSU rDNA were amplified using Taq polymerase (Eurogentec) and primers LR0R (ACC CGC TGA ACT TAA GC) and LR7 (TAC TAC CAC CAA GAT CT) on a Biometra TRIO-Thermoblock, using the following parameters: 94° C denaturation step (1 min.), 47° C annealing step (45 sec.), and 72° C primer extension (2 min.). The cycle was repeated 37 times. A final incubation step at 72° C (7 min.) was added after the final cycle. PCR products were purified with the QIAquick PCR Purification Kit (Qiagen). Cycle sequencing reactions were set up with primers LR0R and LR5 (TCC TGA GGG AAA CTT CG) using the ABI PRISM BigDye Terminator Cycle Sequencing Ready Reaction Kit (Applied Biosystems, CA). Parameters for the reactions were according to Binder et al. (1997).

Cycle sequencing products were run on an ABI 377 automated DNA sequencer (Applied Biosystems).

Phylogenetic analysis

Approximately 900 b of the sequences, starting from primer LR0R, were automatically aligned using ClustalX (Thompson et al., 1997). A final alignment was performed by eye. Gaps in the alignment, due to insertions and deletions, were treated as missing data. All positions have been included in the final alignment. The sequences obtained have been deposited in GenBank (nos. see Tab.1). The distance analysis was calculated with components of the PHYLIP 3.5c packet (Felsenstein, 1995) integrated in ClustalX. The distance matrix was generated using Kimura 2-parameter distances, weighting transition:transversion ratio 2:1. Neighbour-joining (NJ, standard parameters) was used to calculate the tree. To estimate branching order, a bootstrap analysis (Felsenstein, 1985) was run with 1000 heuristic replicates.

Maximum parsimony (MP) analysis was performed with PAUP 4.0b2 (Swofford, 1999) using heuristic search, with tree-bisection-reconnection (TBR) branch-swapping algorithm, MulTrees=on, and zero length branches collapsed. Maxtrees option was set to autoincrease. Bootstrap analysis was run with 100 replicates.

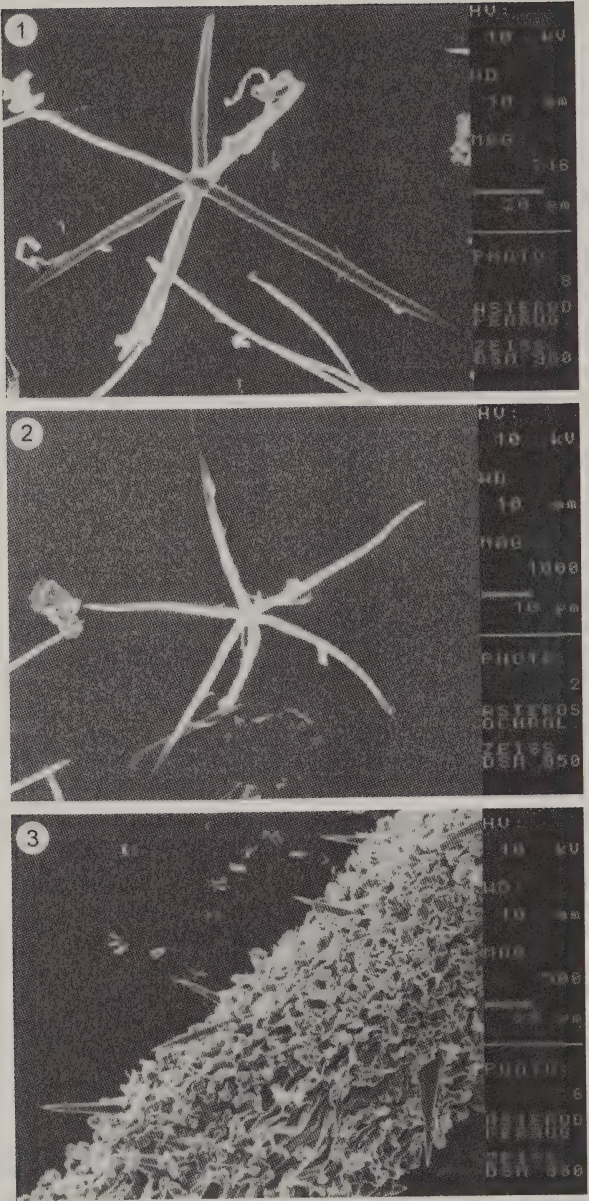
Both, the NJ tree and the MP tree, were rooted with *Tremella foliacea*.

Results

The alignment of the 26 sequences results in 898 sites with 371 variable characters, of which 242 characters are parsimony informative. A length variation of the sequenced nLSU rDNA region separates the taxa investigated in two distinct groups. Sequences of the Lachnocladales (*Dichostereum* and *Vararia*) and *Asterostroma* ranged between 822 b and 829 b. The sequences of the remaining taxa, including *Asterodon*, vary from 853 b (*Coltricia perennis* (L.: Fr.) Murrill) to 879 b (*Phylloporia ribis* (Schuhmach.: Fr.) Ryvarden). The length differences of 50 b – 57 b are caused by insertions/deletions, which are located at positions 409 to 417 and 548 to 577 in the final alignment. The fragment of the outgroup *Tremella foliacea* is 849 b long.

The MP analysis produces 2 trees, each with 1062 steps, consistency index (CI) 0.50, retention index (RI) 0.58 and rescaled consistency index (RC) 0.29. The MP trees (data not shown) show the same topology as the NJ tree (Fig. 4). The strict consensus of the two MP trees (Fig. 5) and the NJ tree (Fig. 4) show both Hymenochaetales (MP, 86%; NJ, 96%) and Lachnocladales (MP, 100%; NJ, 100%) well supported as monophyletic groups. Within the Hymenochaetales, internal nodes are weakly supported by bootstrap values.

Asterodon ferruginosus is distinctly included in the Hymenochaetales. It clusters next to *Phellopilus nigrolimitatus* (Romell) Niemelä, Wagner & Fischer, *Fuscoporia ferruginosa* Schrad.: Fr.) Murrill, *Inonotopsis subiculosa* (Peck) Parm., *Phellinidium ferrugineofusum* (P. Karst.) Fiasson & Niemelä and *Coltricia perennis* (MP, 58%; NJ, 60%). *Hymenochaete rubiginosa* (Dicks.: Fr.) Lév. and *Hydnochaete duportii* Pat. (MP, 92%; NJ, 100%), respectively *Onnia triquetra* (Fr.) Imazeki and *Porodaedalea pini* (Brot.: Fr.) Ames (MP, 53%; NJ, 98%) are sister groups. Within the Lachnocladales, *Asterostroma* (*A. ochroleucum* Bres., *A. medium* Bres.) is the



Figs. 1-3. Scanning electron micrographs of an astero seta from *Asterodon ferruginosus* (1), of an astero seta from *Asterostroma ochroleucum* (2) and of a section from the hydroid hymenophore of *Asterodon ferruginosus* with hymenial setae (3).

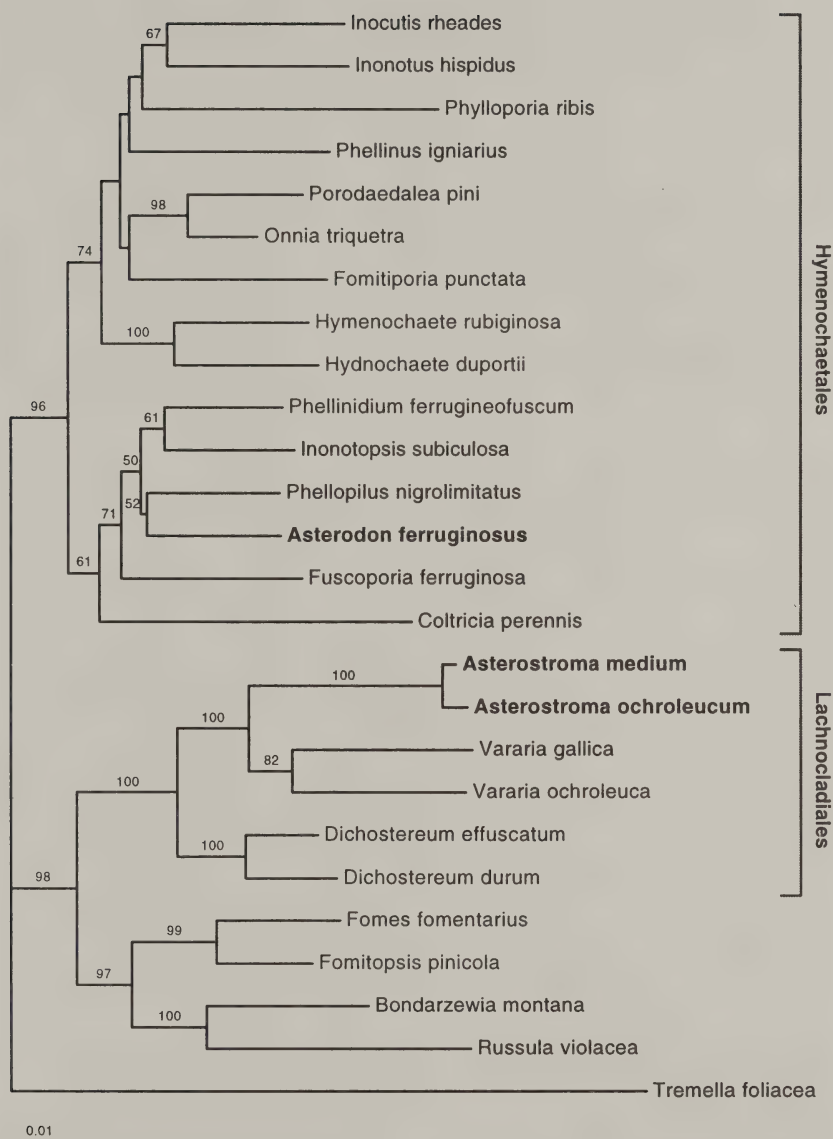


Fig. 4. Phylogram obtained by Neighbour-joining analysis of nLSU rDNA sequences of 26 taxa from the Hymenochaetales, the Lachnocladiales, the Polyporales and the Russulales. The tree was rooted with *Tremella foliacea*. Bootstrap values greater than 50% of 1000 replicates are indicated above the branches.

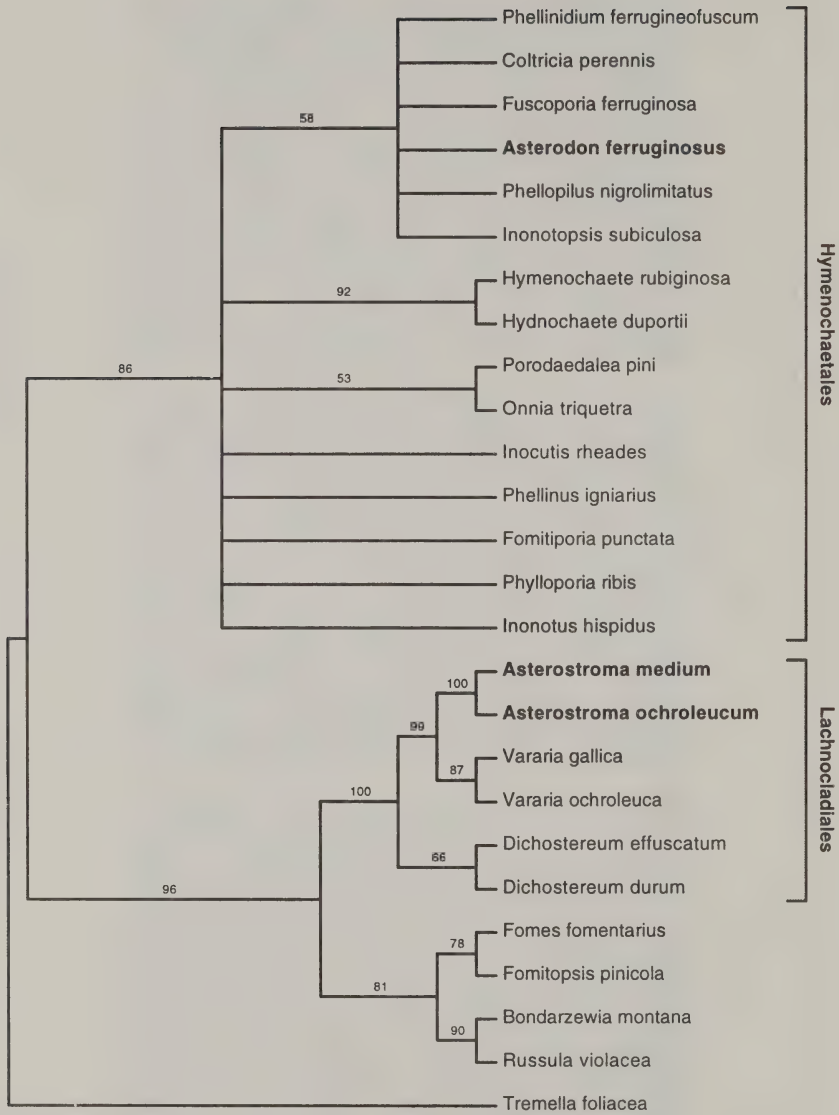


Fig. 5. Strict consensus tree of 2 most parsimonious trees (1062 steps) obtained from parsimony analysis of nLSU rDNA sequences of 26 taxa from the Hymenochaetales, the Lachnocladales, the Polyporales and the Russulales. The tree was rooted with *Tremella foliacea*. Bootstrap values greater than 50% of 100 replicates are indicated above the branches.

sister group (MP, 99%; NJ, 100%) to *Vararia* (*V. gallica* (Bourd. & Galz.) Boidin, *V. ochroleuca* (Bourd. & Galz.) Donk). *Asterodon* and *Asterostroma* are evidently two independent lineages within the Hymenochaetales and the Lachnocladales. The remaining taxa (*Fomes* (Fr.) Fr., *Fomitopsis* P. Karst., *Bondarzewia* Sing. and *Russula* Pers.) form a third clade (MP, 81%; NJ, 96%), which appears as a sister clade to the Lachnocladales (MP, 96%; NJ, 98%).

Discussion

The topologies of both the NJ tree and the MP tree (Figs. 4, 5), clearly demonstrate the two genera *Asterodon* and *Asterostroma* as not closely related to each other. In addition, the phylogenetic analysis supports the view of a monophyletic origin of the Hymenochaetales and the Lachnocladales (Jahn, 1963, 1981; Domański et al., 1973; Oberwinkler, 1977; Jülich 1984; Corner, 1991; Ryvarden, 1991; Hibbett & Donoghue, 1995; Wagner & Fischer, 2001) and a polyphyletic origin of *Phellinus* s. l. and *Inonotus* s. l. (Murrill, 1904, 1905, 1907; Donk, 1969; Fiasson & Niemelä, 1984; Dai, 1995, 1999; Fischer, 1996; Niemelä et al. 2001; Wagner & Fischer, 2001).

Asterodon ferruginosus is distinctly positioned within the Hymenochaetales. This correlates with the typical characteristics of this order, occurring within *Asterodon*, as mentioned above. It is related to *Phellopilus*, *Phellinidium*, *Inonotopsis*, *Fuscoporia* and *Coltricia*, but none of them is a distinct sister group. By the asteroetae and the hydroid hymenophore, *Asterodon* is well separated from all these taxa. Additional morphological and anatomical differences support this separation. The most characteristic are: *Phellopilus nigrolimitatus* varies by its cylindrical basidiospores and a dark line in the context; *Phellinidium ferrugineofuscum* is different by the abundant macroetae in the trama; *Fuscoporia ferruginosa* has typical crystal hyphae in the pores; *Inonotopsis subiculosa* is different by the absence of setae; *Coltricia perennis* also misses the setae, produces stipitate basidiocarps and, besides, a mycorrhizal association with pine and bearberry is suggested (Danielson, 1984). A close relationship to the irpicoid and the corticioid taxa is not supported by the molecular analysis. It is interesting to note that the corticioid *Hymenochaete* and the irpicoid *Hydnochaete* appear as sister groups, positioned within poroid representatives of the Hymenochaetales. So, on the basis of the generated molecular dataset, the suggested evolutionary lineage from corticioid to hydroid or to poroid basidiocarps (Ryvarden, 1991) is not supported within the Hymenochaetales. A common hydroid ancestor for *Asterodon* and *Hydnochaete* is unlikely; this type of hymenophore seems to have developed independently within the two genera.

Asterostroma ochroleucum and *A. medium* stand quite distant from *Asterodon* and the Hymenochaetales. *Asterostroma* is the sister group to *Vararia* within the Lachnocladales. A homogeneous characteristic within the genera of the Lachnocladales clade, *Asterostroma*, *Vararia* and *Dichostereum*, are the gloecystidia (Parmasto, 1970; Jülich, 1984; Hallenberg & Eriksson, 1985; Boidin et al., 1997; Boidin & Michel, 1998). However differences in the exospore of the basidiospores are significant. They vary from tuberculate (*Asterostroma* subgen.

Asterostroma sect. *Asterostroma*) over ornamented (*Dichostereum*) to smooth (*Vararia*, *Asterostroma* subgen. *Austroasterostroma* and *Asterostroma* subgen. *Asterostroma* sect. *Laevispora*). The amyloidity of spore walls is also heterogeneous, basidiospores of *Asterostroma* subgenus *Austroasterostroma* are not amyloid, whereas basidiospores of the remaining taxa are amyloid. A close relationship of *Asterostroma* and the Russulales, here represented by *Russula* and *Bondarzewia*, can be rejected by the phylogenetic analysis. Although *Russula* and *Bondarzewia* have ornamented exospores and gloeoplerous hyphae, they form no distinct clade with the Lachnocladales. A relationship of *Asterostroma* and *Vararia* to *Hymenochaete* also is not indicated.

The results of the phylogenetic analysis (Figs. 4, 5) suggest that asterosetae occurring within *Asterodon* and *Asterostroma* have no homologous origin, but a parallel, independent development can be assumed.

The asterosetae of *Asterodon* (Fig. 1) have to be regarded as an apomorph formation of the typical hymenochaetoid setae. In *Asterodon* the asterosetae are reduced to the basal area of the basidiocarp. The formation of the different types of setae within *Asterodon* (asterosetae, extrahymenial and hymenial setae), were described by Corner (1948) as dependent from the position within the basidiocarp, in correlation with so called form-factors. The question why the formation of asterosetae within the Hymenochaetales only appears in *Asterodon ferruginosus*, remains unsolved. Asterosetae of *Asterodon* are not dextrinoid.

The asterosetae of *Asterostroma* (Fig. 2) can be suggested to have derived from the dichohyphae of *Dichostereum* and *Vararia*, both structures showing a dextrinoid reaction in Melzer (Hallenberg & Eriksson, 1985; Boidin et al., 1997). Within *Asterostroma* asterosetae occur abundantly in the whole basidiocarp. To emphasize the different taxonomic positions of *Asterodon* and *Asterostroma*, the stellate structures should be termed differently. The term asterosetae should be restricted to *Asterodon*, concerning *Asterostroma* the term asterohyphae would be adequate.

Based on differences in staining behaviour and anatomy of the basidiospores a possibly polyphyletic origin of the genus *Asterostroma* should be proved by the inclusion of species from the subgenus *Austroasterostroma* and the subgenus *Asterostroma* section *Laevispora*. These were not available for this study.

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A NEW SPECIES OF MYELOCHROA AND NEW RECORDS IN THE LICHEN FAMILY PARMELIACEAE (ASCOMYCOTINA) FROM SIKKIM, INDIA

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ABSTRACT : *Myelochroa sikkimensis* (Parmeliaceae)
from Sikkim, India is described as new to science. An
additional two species of Parmeliaceae are reported
for the first time from India.

KEY WORDS: *Myelochroa sikkimensis*, *Arctoparmelia*, *Hypotrachyna*

The genus *Myelochroa* was established recently (Elix & Hale 1987; Elix 1994a) to accommodate species which differed from all the other members of *Parmelina* sens. lat. in having a yellow-orange medulla (at least in part) due to the presence of ergochromes (secalonic acids and/or eumittrins) and in containing hopane triterpenes. At that time 19 species were recorded for the genus, which had a predominantly East Asian - North American distribution. Since then several new species and new combinations of *Myelochroa* have been reported, including *M. coreana* Park (1990), *M. nothofagi* Elix (1996), *M. siamea* Kurokawa (1998), *M. crenulata* (Zhao) Hale ex DePriest & B. W. Hale (1998), *M. salazinica* and *M. sinica* Wang, Chen & Elix (2001). Further, *Myelochroa immiscens* (Nyl.) Elix & Hale and *M. lindmanii* (Lynge) Elix & Hale have been transferred to *Parmotrema* (Kurokawa & Arakawa 1997) since these two species have rather broad lobes

with a relatively wide erhizinate zone on the lower surface and lack triterpenes present in other members of *Myelochroa*. Consequently 23 species were accepted in this genus before the present study, and we are now describing a further new species. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Feige *et al.* 1993; Elix *et al.* 1997) and comparison with authentic samples.

Myelochroa sikkimensis Divakar, Upreti, G.P. Sinha & Elix, sp. nov.

Fig.

Thallus ut in *Myelochroa crenulata* sed magnus, coriaceus, lobis latioribus et elobulatibus differt.

Type: INDIA. North Sikkim: Lachung, ca. 2650 m, on bark, G. P. Sinha 1115, 15 July 1996; holo: BSHC.

Thallus corticolous, foliose, loosely to moderately adnate, coriaceous, to 8 cm wide. *Lobes* imbricate, subirregular to sublinear, 2-6 mm wide; margins crenate or dentate, ciliate; cilia simple, dense, evenly distributed, to 0.5 mm long. *Upper surface* pale grey to grey, flat, emaculate, irregularly cracked, ± with black discoloured patches, isidia, soredia and lobules absent. *Medulla* intense lemon-yellow. *Lower surface* black to the margin; rhizines dense, forming a thick mat, simple, squarrose or irregularly branched, to 1 mm long. *Apothecia* not seen. *Pycnidia* black, immersed. *Conidia* bacilliform or weakly bifusiform, 4.5-6.5 × 1 µm.

Chemistry. Cortex K+ yellow; medulla K+ pale yellow, C-, KC-, P-; containing atranorin (major), secalonic acid A (major), xantholepinone A (major), xantholepinone D (trace), zeorin (major), 16β-acetoxypopane-6α,22-diol (major), 6α,16β-diacetoxypopane-22-ol (major), leucotylin (minor), 6α-acetoxypopane-16β,22-ol (trace).

Myelochroa sikkimensis closely resembles *M. crenulata* (Zhao) Hale ex DePriest & B. Hale (Zhao 1964), as these two species have similar loosely to moderately adnate thalli with prominent cilia, lack soredia and isidia and contain secalonic acid A, xantholepinone A, zeorin, 16β-acetoxypopane-6α,22-diol, 6α,16β-diacetoxypopane-22-ol and leucotylin in the medulla. However, *M. sikkimensis* can clearly be separated from *M. crenulata* by the larger thallus with broader lobes (2-6 mm *cf.* 1.5-3 mm wide) and more particularly, the lack of dense imbricate lobules in the thallus centre. The yellow pigments (of unknown structure), xantholepinone A and xantholepinone D are representatives of a group of such pigments first identified in the related species, *Myelochroa xantholepis* (Mont. & v.d.Bosch) Elix & Hale. *Myelochroa sikkimensis* also appears to be related to *Myelochroa sinica* Wang, Chen & Elix (2001), a saxicolous species with identical chemistry which lacks lobules, but differs in having very narrow lobes (0.5-1.2 mm wide), sparse marginal cilia (dense in *M. sikkimensis*) and

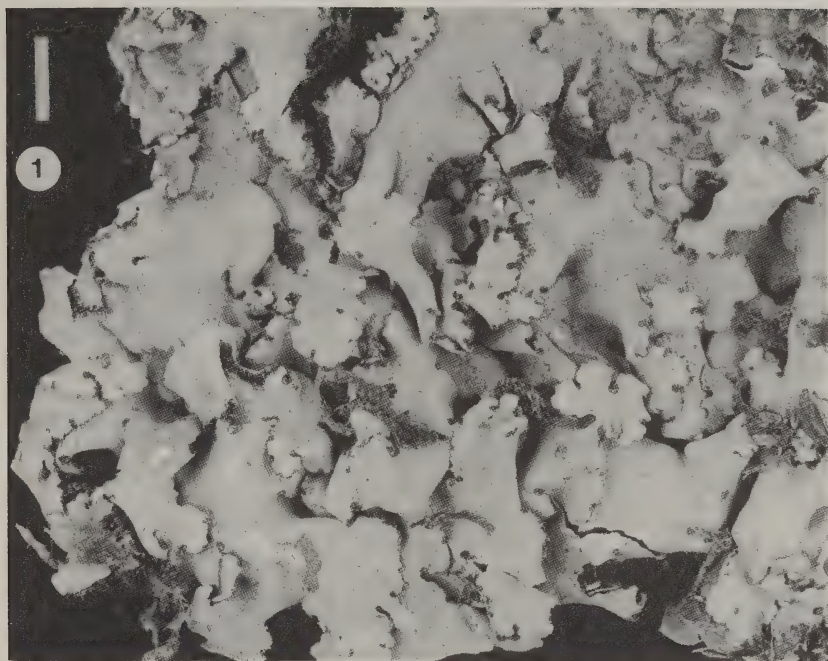


Figure 1. *Myelochroa sikkimensis* (holotype in BSHC). Scale bar = 5.0 mm.

simple rhizines (squamose to irregularly branched in *M. sikkimensis*). At present, the new species is known from the type locality.

New Records of Parmeliaceae for Sikkim, India

Arctoparmelia subcentrifuga (Oxner) Hale, *Mycotaxon* 25: 252 (1986)

Arctoparmelia subcentrifuga is distinguished by the black to black-brown lower surface [similar to *A. separata* (Th. Fr.) Hale] and the markedly and coarsely rugose-pustulate upper surface. This species is known from Greenland, North America, Siberia and Nepal (Hale 1986).

Specimen Examined

INDIA. North Sikkim: Llonak Valley, 4600 m, over mosses on rock, Sinha 1613, 3 Sep. 1999 (BSHC).

Hypotrachyna radiculata (Kurok.) Elix, *Australasian Lichenology* 48: 35 (2001)

This species is chemically identical with *Hypotrachyna majoris* (Vain.) Hale [atranorin (minor), chloroatranorin (minor), salazinic acid (major), consalazinic acid (minor), zeorin (minor)] and both species have $\pm$ capitate, terminal or subterminal soralia. *Hypotrachyna radiculata* is distinguished by the marginal cilia and the lack of revolute or hooded lobe apices. Previously this species was known only from Australia (Elix 1994) and Papua New Guinea (Kurokawa 1979).

Specimens Examined

INDIA. East Sikkim: track between Premlakha and Tonjabir, on bark, G. P. Sinha 897, 7 April 1996 (BSHC). Uttar Pradesh: Almora district, 4 km from Loharkhet towards Dhakuri, 2280 m, on *Quercus* trunk, Awasthi 7551, 8 June 1970 (AWAS).

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A NEW SPECIES AND NEW RECORDS IN THE LICHEN FAMILY PARMELIACEAE (ASCOMYCOTINA) FROM THE PHILIPPINES

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ABSTRACT : *Parmotrema negrosorientalum* from the Philippines is described as new to science. In addition, 13 species of Parmeliaceae are reported for the first time for the Philippines.

KEY WORDS: *Parmotrema negrosorientalum*, *Hypotrachyna*, *Hypogymnia*, *Parmotrema*, *Platismatia*, *Rimelia*

In recent years there has been a significant increase in interest and appreciation of the lichen flora of Philippines, with localised studies of lichen biodiversity (Elix & Bawingan *ined.*), as well as several intensive field investigations by F. Schumm (lichens) & U. Schwarz (bryophytes). We have now undertaken a detailed survey of the recent collections of Parmeliaceae from the Philippine islands of Leyte, Mindanao and Negros culminating in our describing a species new to science and 13 new records for the country. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Feige *et al.* 1993; Elix *et al.* 1997) and comparison with authentic samples.

***Parmotrema negrosorientalum* Elix & Schumm, sp. nov.**

Fig. 1

Thallus ut in *Parmotrema rampoddense* sed magnus, coriaceus, superfice superiore maculata et sporis majoribus differt.

Type: PHILIPPINES. Negros, Negros Oriental Province: Mt Talinis (Cuernos de Negros), Lunga Nature Trail between Camp Vendiola (9°16'N, 123°11'E) and Lake Nailig (9°15'N, 123°10'E), 1170 m, on bark, *F. Schumm & U. Schwarz*, 10 Aug. 2000; holo: herb. Schumm 7521.

Thallus corticolous, foliose, loosely adnate, coriaceous, to 8–12 cm wide. *Lobes* imbricate, subirregular, 5–12 mm wide; margins crenate or irregularly incised-dentate, ascending or revolute; cilia moderately dense, 0.2–5.0 mm long; lobules rare along the lobe margins. *Upper surface* pale grey to grey-green, flat, $\pm$ maculate, irregularly cracked, $\pm$ with black discoloured patches, isidia absent; soralia linear on small incised marginal laciniae or on ascending lobe margins, sometimes spreading submarginally, with marginally sorediate lobes becoming involute; soredia farinose, becoming blackened, with orange patches on older lobes in the thallus centre. *Medulla* white, becoming orange-red in older lobes particularly adjacent to lower cortex. *Lower surface* black, with a white to pale brown erhizinate marginal zone; rhizines unevenly distributed, simple, slender, to 1 mm long. *Apothecia* rare, submarginal, stipitate to substipitate, 3–10 mm wide; disc perforate or imperforate, becoming undulate distorted; thalline exciple strongly rugose and maculate, becoming sorediate, thalline margin crenate. *Ascospores* ellipsoid, 26–30 $\times$ 10–17 μ m. *Pycnidia* rare, immersed - only immature pycnidia observed.

Chemistry. Cortex K+ yellow; medulla K-, C-, KC+ red, P-; pigmented medulla K+ violet; containing atranorin (minor), chloroatranorin (minor), alectoronic acid (major), α -collatolic acid (major), dehydrocollatolic acid (minor), skyrin (minor).

Parmotrema negrosorientalum closely resembles *P. rampoddense* (Nyl.) Hale, as these two species have similar loosely adnate thalli with prominent cilia, marginal soralia and contain alectoronic acid, α -collatolic acid and skyrin in the medulla. However, *P. negrosorientalum* can clearly be separated by the larger, coriaceous thallus (membranaceous in *P. rampoddense*), the often maculate upper surface (emaculate in *P. rampoddense*), ultimately perforate apothecial discs (imperforate in *P. rampoddense*), and the much larger spores (26–30 $\times$ 10–17 μ m cf. 10–12 $\times$ 6–7 μ m). In overall morphology *P. negrosorientalum* closely resembles *P. lobulascens* (Steiner) Hale, but the latter species lacks the orange-red pigmentation of the lower medulla and soralia. This pigmentation is due to substantial concentrations of the bis-anthraquinone, skyrin. At present, the new species is known from several localities in Negros Oriental Province in the Philippines.

Specimens Examined

PHILIPPINES. Negros, Negros Oriental Province: type locality, *F. Schumm & U. Schwarz*, 10 Aug. 2000 (CANB, herb. Schumm 7463, 7465, 7466); Mt Talinis (Cuernos de Negros), Lunga Nature Trail near Lake Yagumyum,



Figure 1. *Parmotrema negrosorientalum* (isotype in CANB). Scale bar = 5 mm.

9°15'N, 123°11'E, 1360 m, on bark, F. Schumm & U. Schwarz, 11 Aug. 2000 (CANB, herb. Schumm 7571).

New Records of Parmeliaceae for the Philippines

Hypotrachyna corneola Kurok. & Moon, *Bull. Bot. Gard. Toyama* 5: 41 (2000)

Previously this species was only known from Papua New Guinea (Kurokawa & Moon 2000).

Specimen Examined

PHILIPPINES. Mindanao, Bukidnon Province: Intavas, west of Malabalay at foot of Mt Kitanglad, 8°12'N, 124°57'E, 1270 m, on bark, F. Schumm & U. Schwarz, 18 Aug. 1999 (herb. Schumm 6237). Cotabato Province: Mt Apo,

Marbel River Campsite, 7°00'N, 125°15'E, 1490 m, on bark, *F. Schumm & U. Schwartz*, 9 Aug. 1999 (herb. Schumm 8031).

Hypotrachyna imbricatula (Zahlbr.) Hale, *Smithsonian Contr. Bot.* **25**: 41 (1975)

A widely distributed subtropical-tropical species also known from the Americas, Southeast Asia, Australia, Papua New Guinea and Hawaii (Elix 1994a; Hale 1975).

Specimen Examined

PHILIPPINES. Mindanao, Bukidnon Province: Intavas, west of Malabalay at foot of Mt Kitanglad, 8°12'N, 124°57'E, 1270 m, on bark, *F. Schumm & U. Schwartz*, 18 Aug. 1999 (CANB, herb. Schumm 6246).

Hypotrachyna physcioides (Nyl.) Hale, *Smithsonian Contr. Bot.* **25**: 54 (1975)

A common species in tropical America, India, Thailand, Malaysia and Papua New Guinea (Hale 1975; Kurokawa 1979; Pooprang *et al.* 1999).

Specimens Examined

PHILIPPINES. Mindanao, Bukidnon Province: west of Malabalay, intermediate camp site, Mt Kitanglad, 8°10'N, 124°56'E, 1870-2800 m, on bark in tropical montane rainforest, *F. Schumm & U. Schwartz*, 19 Aug. 1999 (herb. Schumm 6297). Cotabato Province: summit of Mt Apo, 6°59'N, 125°16'E, 2900 m, on rocks, *O. L. Bernabe*, 12 Aug. 1999 (CANB, herb. Schumm 6194, 6202); between Lake Venado and summit of Mt Apo, 6°59'-7°00'N, 125°16'-125°20'E, 2200-2800 m, on bark in tropical montane rainforest, *F. Schumm & U. Schwartz*, 11 Aug. 1999 (herb. Schumm 6151, 6181).

Hypotrachyna reducens (Nyl.) Hale, *Smithsonian Contr. Bot.* **25**: 60 (1975)

A temperate and tropical species also known from Australia, Malaysia (Sabah), New Guinea, Central and South America (Elix 1994a; Hale 1975; Kurokawa 1979).

Specimen Examined

PHILIPPINES. Mindanao, Bukidnon Province: west of Malabalay, intermediate camp site, Mt Kitanglad, 8°10'N, 124°56'E, 1870-2800 m, on bark in tropical montane rainforest, *F. Schumm & U. Schwartz*, 19 Aug. 1999 (CANB, herb. Schumm 6273).

Hypogymnia zeylanica (R. Sant.) Awasthi & Singh

This species was previously known only from Sri Lanka, India (Awasthi & Singh 1971) and Papua New Guinea (Elix & Jenkins 1989).

Specimen Examined

PHILIPPINES. Cotabato Province: Mt Apo, swamp region on west bank of Lake Venado, 7°00'N, 125°16'E, 2210 m, on bark in open montane area, U. Schwartz, 20 Mar. 1999 (B, herb. Schumm 5479).

Parmotrema cooperi (J. Steiner & Zahlbr.) Sérus., *Bryologist* 87: 4 (1984)

This species was previously known from Africa, Madagascar, Asia, India (Hale 1965; Krog & Swinscow 1981) and Australia (Elix 1994b).

Specimen Examined

PHILIPPINES. Cotabato Province: near Ilomavis, on the road past Kidapawan, 7°02'N, 125°11'E, 730 m, on Cocos palm, F. Schumm & U. Schwartz, 7 Aug. 1999 (CANB, herb. Schumm 5885).

Parmotrema dilatatum (Vain.) Hale, *Phytologia* 28: 335 (1974)

This species is widespread in Africa, India, Australia, New Zealand, Papua New Guinea and South America (Elix 1994b; Hale 1965; Krog & Swinscow 1981; Louwhoff & Elix 2000).

Specimen Examined

PHILIPPINES. Mindanao, Bukidnon Province: west of Malabalay, intermediate camp site, Mt Kitanglad, 8°10'N, 124°56'E, 1870-2800 m, on bark in tropical montane rainforest, F. Schumm & U. Schwartz, 19 Aug. 1999 (CANB, herb. Schumm 6303).

Parmotrema lobulascens (Steiner) Hale, *Phytologia* 28: 337 (1974)

Previously this species was known from Africa (Krog & Swinscow 1981) and Asia (Hale 1965).

Specimens Examined

PHILIPPINES. Mindanao, Bukidnon Province: west of Malabalay, intermediate camp site, Mt Kitanglad, 8°10'N, 124°56'E, 1870-2800 m, on bark in tropical montane rainforest, F. Schumm & U. Schwartz, 19 Aug. 1999 (herb. Schumm 6272). Cotabato Province: Mt Apo, near Lake Venado, 7°00'N, 125°16'E, 2200 m, on bark in tropical montane rainforest, F. Schumm & U. Schwartz, 10 Aug. 1999 (CANB, herb. Schumm 6071, 6084).

Parmotrema permutatum (Stirt.) Hale, *Phytologia* 28: 338 (1974)

This species is known from Africa, India, Indonesia, Papua New Guinea, Australia, Central and South America (Elix 1994b; Hale 1965; Krog & Swinscow 1981; Louwhoff & Elix 2000).

Specimen Examined

PHILIPPINES. Mindanao, Cotabato Province: near the Lake Agko campsite at foot of Mt Apo, 7°01'N, 125°13'E, 1240 m, on bark, F. Schumm & U. Schwartz, 7 Aug. 1999 (herb. Schumm 5941).

Parmotrema rampoddense (Nyl.) Hale, *Phytologia* 28: 338 (1974)

A widespread species known from West Africa, North, Central and South America, Sri Lanka and India (Hale 1965), Australia (Elix 1994b) and Papua New Guinea (Louwhoff & Elix 2000).

Specimens Examined

PHILIPPINES. Leyte, Leyte Province: Lake Kasudsuran near Barangay Liberty (Ormoc City), 11°02'N, 124°45'E, 740 m, on bark, F. Schumm & U. Schwartz, 23 Aug. 2000 (herb. Schumm 7943, 7948). Mindanao, Cotabato Province: near the Lake Agko campsite at foot of Mt Apo, 7°01'N, 125°13'E, 1240 m, on bark, F. Schumm & U. Schwartz, 7 Aug. 1999 (herb. Schumm 5916, 5978); Mt Apo, near Lake Venado, 7°00'N, 125°16'E, 2200 m, on bark in tropical montane rainforest, F. Schumm & U. Schwartz, 10 Aug. 1999 (herb. Schumm 6115). Negros, Negros Oriental Province: Mt Talinis (Cuernos de Negros), Lunga Nature Trail between Barangay Lunga (9°17'N, 123°14'E) and Camp Vendiola (9°16'N, 123°11'E), 1030 m, on bark, F. Schumm & U. Schwarz, 10 Aug. 2000 (herb. Schumm 7443); Mt Talinis (Cuernos de Negros), Lunga Nature Trail between Camp Vendiola (9°16'N, 123°11'E) and Lake Nailig (9°15'N, 123°10'E), 1180 m, on bark, F. Schumm & U. Schwarz, 10 Aug. 2000 (herb. Schumm 7467, 7533); Mt Talinis (Cuernos de Negros), Lunga Nature Trail, between Lake Yagumyum and Bediao-Dauin, 9°15'N, 123°11'E, 1240 m, on bark, F. Schumm & U. Schwarz, 12 Aug. 2000 (herb. Schumm 7613).

Parmotrema sancti-angelii (Lynge) Hale, *Phytologia* 28: 339 (1974)

This pantropical species has been reported previously from Central and South America, eastern and southern Africa, Papua New Guinea and Australia (Elix 1994b; Hale 1965; Krog & Swinscow 1981; Louwhoff & Elix 2000).

Specimens Examined

PHILIPPINES. Cotabato Province: near Ilomavis, on the road past Kidapawan, 7°02'N, 125°11'E, 730 m, on bark, F. Schumm & U. Schwartz, 7 Aug. 1999 (CANB, herb. Schumm 5869, 5874, 5903, 5908).

Platismatia regenerans W. Culb. & C. Culb., *Contr. U.S. Natl Herb.* **34**: 547.(1968)

This species has been reported previously from the high mountains of Sabah, Malaysia (Culberson & Culberson 1968).

Specimen Examined

PHILIPPINES. Cotabato Province: Mt Apo, swamp region on west bank of Lake Venado, 7°00'N, 125°16'E, 2210 m, on bark in open montane area, U. Schwartz, 20 Mar. 1999 (herb. Schumm 5485).

Rimelia austrocetrata (Elix & J. Johnst.) Hale & A. Fletcher, *Bryologist* **93**: 26 (1990)

This Australasian species is known from Australia, New Zealand, Papua New Guinea, Norfolk and Lord Howe Islands (Elix 1994c; Hale & Fletcher 1990; Louwhoff & Elix 1999, 2000).

Specimens Examined

PHILIPPINES. Cotabato Province: between Lake Venado and summit of Mt Apo, 6°59'-7°00'N, 125°16'-125°20'E, 2200-2800 m, on bark in tropical montane rainforest, F. Schumm & U. Schwartz, 11 Aug. 1999 (CANB, herb. Schumm 6126); Mt Apo, swamp region on east bank of Lake Venado, 7°00'N, 125°16'E, 2210 m, on mossy rocks, U. Schwartz, 20 Mar. 1999 (B, herb. Schumm 5441).

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USTILAGO DEYEUXICOLA SP. NOV. FROM CHINA

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ABSTRACT: A new species of Ustilaginomycetes, *Ustilago deyeuxicola* on *Deyeuxia angustifolia* from China is described and illustrated. It is compared with the smut fungi of *Deyeuxia* and *Calamagrostis*, and a key to these species is presented.

KEY WORDS: *Calamagrostis*, *Deyeuxia angustifolia*, Ustilaginomycetes, smut fungi.

INTRODUCTION

A smut fungus on the leaves of *Deyeuxia angustifolia* (Kom.) Y. L. Chang was collected in China. *Deyeuxia*, in the subfam. Pooideae, tribe Aveneae, subtribe Alopecurinae, is considered by many agrostologists to be a synonym of *Calamagrostis*. According to Clayton & Renvoize (1986:135), *Calamagrostis*, with c. 270 species in temperate regions throughout the world and on tropical mountains, is variable and sometimes divided into three genera: *Deyeuxia* P. Beauv., *Calamagrostis* Adanson, and *Aniselytron* Merr.

On *DEYEUXIA* three smut fungi have been described: 1. *Tilletia deyeuxiae* L. Ling (1945:1), type on *D. sylvatica* (Schrader) Kunth var. *laxiflora* Rendle, China. 2. *T. inolens* McAlpine (1896:154), type on *D. forsterii* Kunth, Australia, and 3. *Ustilago deyeuxiae* L. Guo (1993:51), type on *D. arundinacea* (L.) Beauv., China. This last species is very close to *Ustilago scrobiculata* Liro (1924:68), type on *Calamagrostis arundinacea* (L.) Roth, Finland, and they are considered by the senior author to be synonyms.

On *CALAMAGROSTIS* seven smut fungi have been reported: 1. *Tilletia deyeuxiae* (see above). 2. *Urocystis calamagrostidis* (Lavrov) Zundel (1953:312), based on *Tubercinia calamagrostidis* Lavrov (1937:2), lectotype (designated by Zundel) on *C. epigeios* (L.) Roth, Ukraine. 3. *Ustilago calamagrostidis* (Fuckel) G. P. Clinton (1902:138), based on *Tilletia calamagrostidis* Fuckel, in Fuckel, Fgi. rhenani exs. no. 1925, 1867, type on *C. epigeios* (L.) Roth, Germany. 4. *U. hypodytes* (Schltld.) Fries (1832:518), based on *Caeoma hypodytes* Schlechtendal (1824:129), type on *Elymus arenarius* L., Germany. The occurrence of this smut on *Calamagrostis* is doubtful and has to be verified. 5. *U. scrobiculata* (see above). 6. *U. striiformis* (Westend.) Niessl (1876:1), based on *Uredo striiformis* Westendorp (1851:406), type on *Holcus lanatus* L., Belgium, and 7. *Ustilentyloma brefeldii* (Krieger) Vánky (1991:491), based on *Entyloma brefeldii* Krieger, 1896:(145), and in Krieger, Fgi. saxon. no. 104, 1896, type on *Phalaris arundinacea* L., Germany.

· No smut fungus is known on *ANISELYTRON*.

RESULTS

The fungus on *Deyeuxia angustifolia* from China differs from all known smut fungi on *Deyeuxia* and *Calamagrostis*, mentioned above (comp. the key below). It is described as:

Ustilago deyeuxicola Vánky & L. Guo, sp. nov.

Typus in matrice *Deyeuxia angustifolia* (Kom.) Y. L. Chang (*Calamagrostis angustifolia* Kom., det. Liu Liang), China, Heilongjiang, Fuyuan, 48°21' N, 134°18' E, 8.VIII.2000, leg. L. Guo 1890. Holotypus in HMAS 80864. Isotypus in HUV 19500!

Sori in foliis et vaginis foliorum strias longas, parallelas inter venas formantes, cca. 0,5 mm lati, 0,5–5 cm longi vel propter coalescentiam longiores, primo subepidermales, serius disrupti et massam atrobrunneam, semiagglutinatam usque pulveream sporarum ostendentes et saepe laminam foliorum contundentes. *Sporae* subglobosae, ovoideae, late ellipsoidales usque parum irregulares (5,5–)6–7,5 x 6,5–10 µm, flavidobrunneae; pariete aequaliter crasso (cca. 0,5 µm), rarius usque moderate dense, subtiliter verruculoso. Imago obliqua spora in microscopio LM levis vel indistincte undulata.

Sori (Fig. 1) in the leaves and leaf-sheaths forming long, parallel striae between the veins, c. 0.5 mm wide, 0.5–5 cm long or longer by confluence, first subepidermal, later bursting and revealing the dark brown, semi-agglutinated to powdery mass of spores which are scattered and the leaf-blades often shred. *Spores* (Figs. 2, 3) subglobose, ovoid, broadly ellipsoidal to slightly irregular (5.5–)6–7.5 x 6.5–10 µm, yellowish-brown; wall evenly thick (c. 0.5 µm), sparsely to moderately densely, finely verruculose; spore profile seen in LM is smooth to indistinctly wavy.

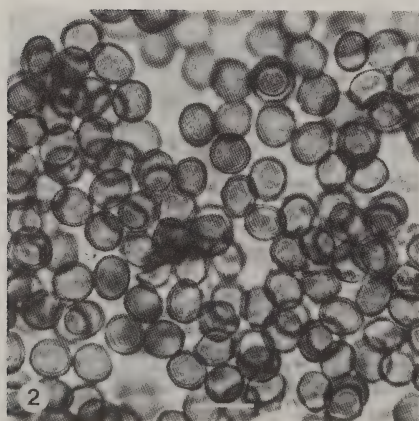
On Gramineae: *Deyeuxia angustifolia* (Kom.) Y. L. Chang (*Calamagrostis angustifolia* Kom.), China. Known only from the type collection.



Fig. 1. Sori of *Ustilago deyeuxicola* Vánky & L. Guo on *Deyeuxia angustifolia* (Kom.) Y. L. Chang, forming striae on the leaves and leaf sheaths (type). To the right a healthy inflorescence.
Bar = 1 cm.

Key to the smut fungi of *Calamagrostis*, including *Deyeuxia*

1. Sori inconspicuous. Spores subhyaline to pale yellow, embedded in the leaf tissue, not powdery *Ustilentyloma brefeldii*
- Sori conspicuous. Spores pigmented, powdery 2
2. Spores agglutinated in permanent balls surrounded by sterile cells *Urocystis calamagrostidis*
- Spores not in balls 3
3. Sori naked surrounding the internodes. Spores 4–6(–7) μm long (?) *Ustilago hypodytes*
- Sori otherwise. Spores larger 4
4. Sori in seeds. Spores longer than 19 μm , tuberculate 5
- Sori in leaves forming striae. Spores shorter than 19 μm , verrucose or echinulate 6
5. Spores 19–26 μm long, tubercles 1.5–2 μm high *Tilletia deyeuxiae*
- Spores 36–44 μm long, tubercles up to 5 μm high *Tilletia inolens*
6. Spores 12–19 μm long 7
- Spores smaller 8
7. Spores with irregular warts the bases of which are confluent into irregular, interrupted meshes *Ustilago scrobiculata* (incl. *U. deyeuxiae*)
- Spores with regular, isolated, prominent, densely situated spines which are not fusing *Ustilago calamagrostidis*
8. Spores 9–15(–16) μm long, finely to prominently, densely echinulate. Spore profile finely serrulate *Ustilago striiformis*
- Spores 6.5–10 μm long, sparsely, finely verruculose. Spore profile smooth *Ustilago deyeuxicola*



Sorus and spore morphology of *Ustilago deyeuxicola* on *Deyeuxia* (tribe Aveneae) are rather close to those of *U. davisii* Liro on *Glyceria* species (tribe Meliceae). However, *U. deyeuxicola* differs from *U. davisii* in having smaller and darker spores. These, in *U. davisii* are 8–12 μm long, pale brown, minutely, moderately densely punctate to verrucose-echinulate.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. S. Tóth (Gödöllő, Hungary) for providing the Latin description, to Dr. R. G. Shivas (Herb BRIP, Qld., Australia) for reading the manuscript and serving as pre-submission reviewer, and to Prof. Liu Liang (Beijing, China) for identifying *Deyeuxia angustifolia*.

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Figs. 2, 3. Spores of *Ustilago deyeuxicola* Vánky & L. Guo in LM and in SEM (type). Bars = 10 μm .

MYCOTAXON

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HYALOSETA NOLINAE, ITS ANAMORPH MONOCILLIUM NOLINAE, AND NIESSLIA AGAVACEARUM, NEW MEMBERS OF THE NIESSLACEAE, HYPOCREALES, FROM LEAVES OF AGAVACEAE

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Abstract: *Hyaloseta*, a new genus with superficial, setose ascomata and unitunicate asci, is described from dead leaves of *Nolina micrantha*. The accompanying anamorph is *Monocillium nolinae*, a new species, in which the hyphae bear setae like those on the ascomata of *Hyaloseta*. *Niesslia agavacearum* sp. nov. is described from leaves of *Dasyllirion leiophyllum*. No anamorph has been discovered for this species.

Key words: ascomycete, *Dasyllirion*, fungi, *Nolina*, systematics

INTRODUCTION

Nolina micrantha I.M. Johnst. and *Dasyllirion leiophyllum* Engelm. are plants in the Agavaceae that have long, slender, fibrous leaves arising from a short subterranean or above-ground caudex. Both genera are perennials, and the leaves may remain on the caudex for several years while decomposition takes place. Two species of superficial, small, setose ascomycetes were discovered on dead leaves of these plants. The lack of paraphyses, setose ascomata with unitunicate asci, hyaline, 1-septate ascospores, and peridia having *textura epidermoidea*, place these fungi in the Hypocreales. The families in this order have been revised and extensively redescribed, and new genera and new species of existing genera within these families have also been described (Samuels and Barr 1997; Rossman *et al.* 1999).

MATERIALS AND METHODS

Conidiophores on small portions of the subiculum surrounding *Hyaloseta* ascomata were suspended in a drop of sterile tap water on commercial potato dextrose agar (PDA, BBL) in a Petri plate, and the conidial suspension was spread with a sterile glass rod. Germlings from single conidia were then isolated and grown on PDA at room temperature.

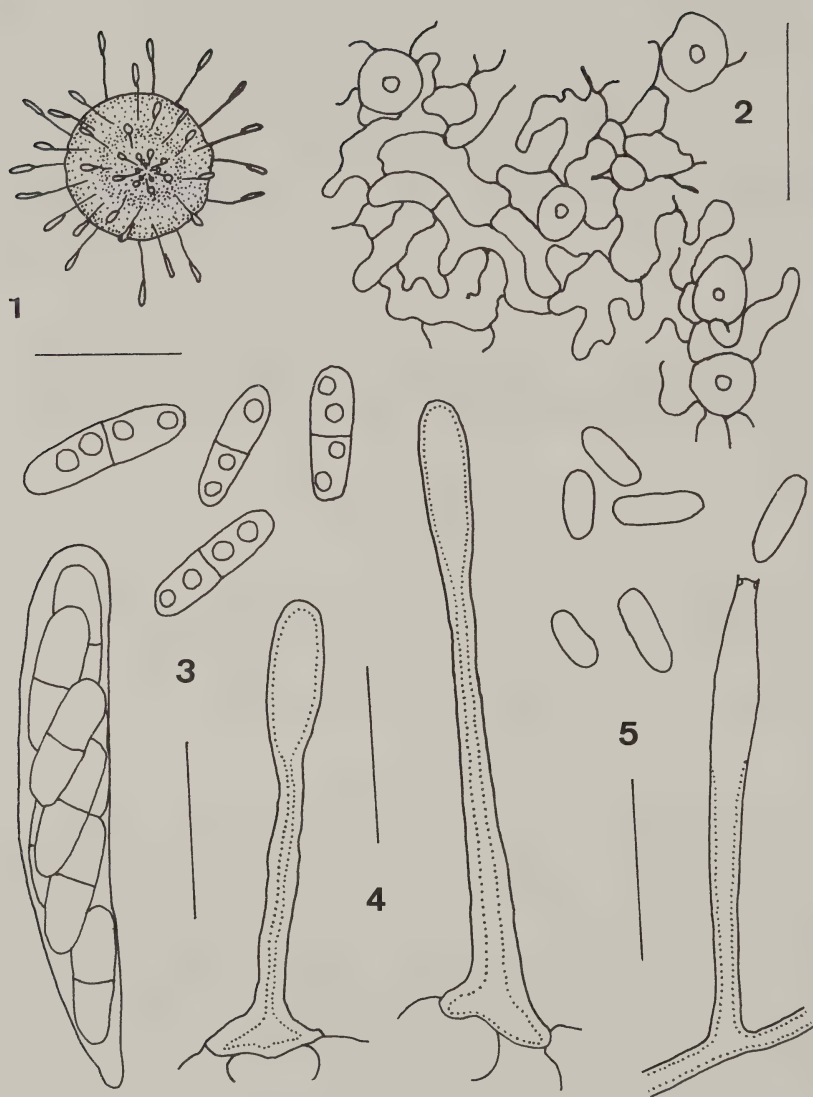


FIG. 1-4. *Hyaloseta nolinae*. FIG. 1. Top view of ascoma. Bar = 100 μ m. FIG. 2. *Textura epidermoidea* of ascomata with more or less circular bases of broken setae. Bar = 10 μ m. FIG. 3. Ascus and ascospores. Bar = 10 μ m. FIG. 4. Hyaline setae with swollen, ellipsoid tips on ascomata. Bar = 10 μ m. FIG. 5. *Monocillium nolinae*. Conidiophore and conidia. Bar = 10 μ m.

TAXONOMY

Hyaloseta A.W. Ramaley gen. nov.

Ascomata in subiculo hyalino insidens, superficialia, sphaeroidea, ostiolum periphysibus, papilla nulla. Peridium molle, tenue, ex stratis cellularum brunnearum extra et stratis cellularum hyalinarum, aliquantum compressarum intra compositum, stratum extimum ex textura epidermoidea compositum; setas hyalinas ferens. Asci unitunicati, octospori. Ascospores 1-septatae, hyalinae.

Ascomata in a hyaline subiculum, superficial, sphaeroid, the ostiole periphysate, lacking a papilla. Peridium soft, thin, composed of brown cell layers on the outside and somewhat compressed, hyaline cell layers on the inside, the outermost layer composed of *textura epidermoidea*; bearing hyaline setae. Asci unitunicate, octosporous. Ascospores 1-septate, hyaline. Monotype: *Hyaloseta nolinae*.

Hyaloseta nolinae A.W. Ramaley sp. nov.

FIGS. 1-4

Anamorph: *Monocillium nolinae* A.W. Ramaley sp. nov.

Ascomata solitaria vel aggregata, in subiculo hyalino cum fungis aliis foliis emortuis insidens, superficialia, sphaeroidea, collabentia, (50-) 75-125 (-150) μm diam, ostiolo, papilla nulla. Peridium molle, tenue, paries 6.4-16 μm crassus, ex 4-7 stratis cellularum brunnearum extra et stratis cellularum aliquantum compressarum, hyalinarum intra compositum, stratum extimum ex textura epidermoidea compositum; setas aseptatas, hyalinas, crassiparietibus, usque ad 48 μm longas ferens, septum basale raro, setae expansae, apex plus minusve ellipsoideus, lucens, elongatus, usque ad 3.2 μm crassus, setae ascomatibus super basim incrassatam saepe disrumpentes. Asci unitunicati, oblongi, 28-48 x 3.2-4.8 μm , octospori. Aliquot filii grandicellularis, deliquescentia, tenuiparietibus, hymenio apice inter ascos juvenes extensi. Ascospores oblongae-ellipsoideae, 5.6-7.2 (-9.6) x 2.4 μm , 1-septatae, hyalinae, laeves, tenuiparietibus, utraque hemispora plerumque bigutulata, plus minusve inasco biseriatae.

HOLOTYPE: U.S.A. NEW MEXICO: Lincoln County, Valley of Fires, U. S. Hwy 380, mile 61, along roadside, 22 October 1997. In foliis emortuis *Nolina micrantha* I.M. Johnst., a *Annette Ramaley* n. 9706B lectus in UC depositus.

Ascomata solitary or aggregated, on hyaline hyphal subiculum on dead leaves with other fungi, superficial, sphaeroid, collabent, (50-) 75-125 (-150) μm diam., ostiolate, lacking a papilla. Peridium soft, thin, wall 6.4-16 μm thick, composed of 4-7 brown cell layers on the outside, and somewhat compressed hyaline cell layers on the inside, the outermost layer of *textura epidermoidea*; ascomata bearing aseptate, thick-walled, hyaline setae up to 48 μm long, basal septum rare, setae expanding to a glistening, elongate, swollen, more or less ellipsoid tip, up to 3.2 μm wide, often broken from ascomata above the thickened base. Asci unitunicate, oblong, 28-48 x 3.2-4.8 μm , octosporous. Among young asci, a few large-celled, thin-walled deliquescent filaments extend to the hymenium from the apex. Ascospores oblong-ellipsoid, 5.6-

7.2 (-9.6) $\times$ 2.4 μm , 1-septate, hyaline, smooth, thin-walled, each hemispore usually biguttulate, more or less biserial in ascus.

Monocillium nolinae A.W. Ramaley sp. nov.

FIG. 5

Mycelium album, superficiale, plerumque effusum, subiculum crassius in areis aliquot, apprime prope ascomata formans. Hyphae hyalinae, ramosae, setas fragiles, crassiparietibus, apicibus elongatis, strumulosus plus minusve ellipsoideis et conidiophora hyalina, aramosa, laevia, aseptata, strumulosa ferentes. Conidiophora ex cellula conidiogena usque ad 40 μm longa constantia, septum basale destitutum, omnia collectionem singularem, terminalem conidiorum incoloratorum ferentia. Conidia ellipsoidea, 2.8-6.4 $\times$ 1.2-2.0 μm , aseptata, hyalina, laevia, tenuiparietibus.

HOLOTYPE: NEW MEXICO. Lincoln County, Valley of Fires, U. S. Hwy 380, mile 61, along roadside, 22 October 1997. *In foliis emortuis Nolina micrantha* I. M. Johnst., a *Annette Ramaley* n. 9706B lectus in UC depositus.

Mycelium white, superficial, mostly effuse, forming thicker subiculum in some areas, especially near ascomata. *Hyphae* hyaline, branched, bearing brittle, thick-walled setae with elongate, swollen, more or less ellipsoid apices, and conidiophores. *Conidiophores* consisting only of a conidiogenous cell, hyaline, unbranched, smooth, aseptate, swollen, up to 40 μm long, a short collarette occasionally visible, usually lacking a basal septum separating it from hypha, each bearing a single, terminal, accumulation of hyaline conidia. *Conidia* ellipsoid, 2.8-6.4 $\times$ 1.2-2.0 μm , aseptate, hyaline, smooth, thin-walled.

Characteristics in culture on PDA: After 2 d germinating conidia consist of a single filament 75-175 μm long, or with one to a few very short branches; after 3 d the hyphae have many short branches. After 1 w, colonies approximately circular, 1.1-1.5 mm diam., white, flat. After 8 d, conidia present, colony with numerous conidiophores each consisting of a single cell. Conidiophores 22.4-40 μm long, usually ca 0.8 μm wide at the base, usually separated from the hyphae bearing them by a basal septum, thin-walled from ca. the midpoint to the apex, thicker-walled below, usually inflated, up to 2.4 μm broad at the midpoint, then tapering to ca. 0.8 μm at the tip; mononematous, each conidiophore terminated by a single phialide. Phialides thickened periclinally, a short collarette occasionally visible. Conidia ellipsoid, 4.8-6.4 $\times$ 1.6-2.4 μm , unicellular, hyaline, smooth. After 3 w, colonies ca. 13 mm diam., somewhat raised, margins white, becoming pale yellow on reverse, white aerial hyphae formed centrally, hyphal ropes also formed, aerial hyphae and hyphal ropes may bear conidiophores. Setae developing after ca 2 w, similar to those found in nature but more often with a basal septum separating the seta from the hyphal cell bearing it, sometimes elongating into a hyphal branch.

Ascospores were not cultivated so cultures of the teleomorph and presumed anamorph could not be compared. However, setose ascomata in the conidiogenous subiculum bearing the same distinctive setae, and development of similar setae and conidiogenous cells in cultures from conidia unite the stages.

Within the Hypocreales, *Hyaloseta* has characteristics of both the Niessliaceae and the Bionectriaceae as delimited by Rossman *et al.* (1999). In the Niessliaceae, in which setose members are common, the superficial ascomata are dark colored at maturity, whereas most members of the Bionectriaceae have pale-colored ascomata. As is true for the Bionectriaceae, with few setose members, *Hyaloseta* ascomata are usually aggregated and the setae are hyaline, not brown as in the Niessliaceae. Cell walls of *textura epidermoidea* are common in the Niessliaceae but also present in some of the Bionectriaceae. Although *Hyaloseta* ascomata have characteristics of both families, the *Monocillium* anamorph has been found only in the Niessliaceae.

Five species of *Monocillium* described by Gams (1971) have structures that more or less resemble the setae of *M. nolinae*. *Monocillium indicum* S. B. Saksena, *M. constrictum* W. Gams, and *M. bulbiliosum* W. Gams were not linked to a perfect phase, but their cultural characteristics separate them from *M. nolinae*. Though not directly comparable, colony growth of *M. nolinae* is slower than any of these species. In 10 days, colonies of *M. indicum* attain 20-22 mm diam, *M. constrictum* 7-8 mm diam, and *M. bulbiliosum* 8-9 mm diam whereas the slow-growing colonies of *M. nolinae* are only 1.1-1.5 mm diam in 7 days. *Monocillium constrictum* colonies are whitish-rose-pale orange and those of *M. bulbiliosum* have a pale rose reverse, whereas colonies of *M. indicum* are white or light ocher, and *M. nolinae* has white colonies that become pale yellow on the reverse after ca 3 weeks. In contrast to the ellipsoid conidia of *M. nolinae*, *M. indicum* conidia are napiform, and *M. constrictum* conidia are obovate to clavate. Both *M. indicum* and *M. bulbiliosum* form sclerotia in culture. Other *Monocillium* species with structures resembling *M. nolinae* setae were linked to perfect phases. The teleomorph for *M. granulatum* (Fuckel) W. Gams is *Niesslia exosporioidea* (Desm.) Winter and for another *Monocillium* in culture, *Niesslia exigua* (Sacc.) Kirschst. All these *Monocillium* species have hyaline setose appendages, but in contrast to *Hyaloseta*, the *Niesslia* teleomorphs have robust, deep brown setae quite different in appearance from those of the anamorphs. Photographs of a sixth *Monocillium*-like entity show upright, hyaline, hyphal appendages (Hyde *et al.* 1999) resembling *M. nolinae* setae. *Niesslia palmicola* K.D. Hyde, Goh, J.E. Taylor & J. Fröhl., the teleomorph, bears similar appendages. This fungus can be distinguished from *Hyaloseta* in several ways. The conidiogenous cells are septate and thin-walled except at the swollen apex, whereas conidiogenous cells of *M. nolinae* are aseptate and have thickened walls below the subapical swelling. The teleomorphs are distinguished by the *textura epidermoidea* of the *Hyaloseta* peridium, rather than

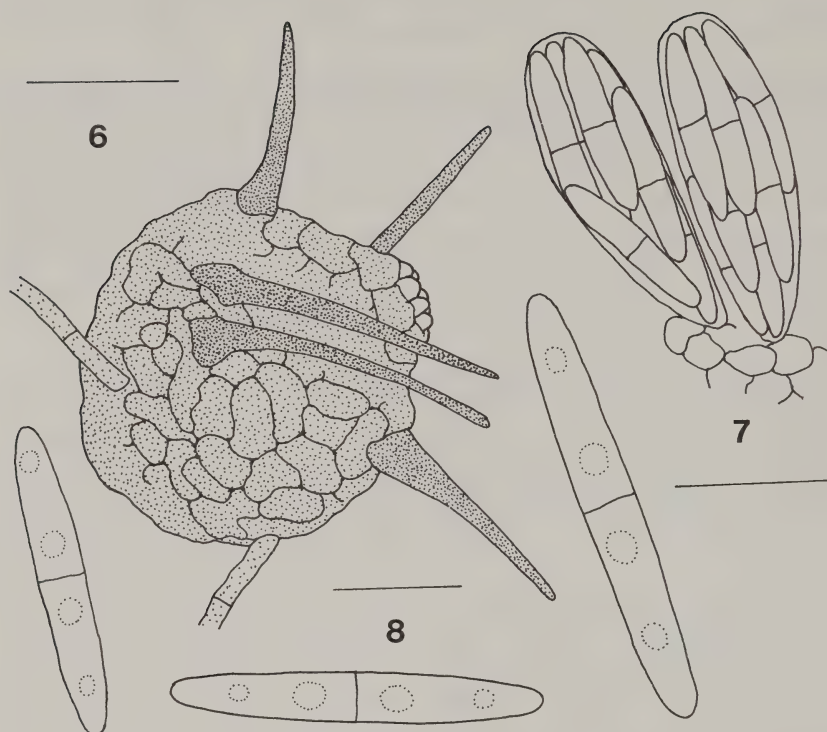


FIG. 6-8. *Niesslia agavacearum*. FIG. 6. Ascoma. Bar = 20 μ m. FIG. 7. Asci. Bar = 10 μ m. FIG. 8. Ascospores. Bar = 5 μ m.

textura angularis, and ascospores of *Hyaloseta* are considerably smaller (5.6-7.2 x 2.4 μ m vs 10-15 x 2.5-4 μ m). In addition, the hyphal and ascomatal appendages of *Hyaloseta* are thick-walled setae rather than thin-walled hairs. Although the *Monocillium* anamorph is similar to those of some *Niesslia* species, the *Hyaloseta* teleomorph is distinguished by possessing thick-walled, hyaline setae expanded apically, rather than the darkly pigmented, pointed, setae typical of the genus *Niesslia*.

Niesslia agavacearum A.W. Ramaley sp. nov.

FIGS. 6-8

Anamorph: *Incognita*

Ascomata superficialia, saepe in gregibus parvis, super stromatibus hypharum brunnearum adpressarum, globosa, 36-60 μ m diam, plerumque subbrunnea, setosa, ostiolata. Peridium tenue, ex 1 (-2) stratis

cellularum brunneoparietibus extra, stratum extimum ex textura epidermoidea sed saepe obscura per pigmentum positum, et 1-2 stratis cellularum compressarum, hyalinarum intra constans; 4-8 setas usque ad 50 μm longas, acutas, brunneas, crassiparietibus, plerumque aseptatas, interdum septo prope basem strumulosam ferens. Asci unitunicati, 19.2-22.4 x 6.4 μm , ellipsoidei vel breviblongi, octospori. Ascospores cylindraceae-fusoides, extrema rotunda, 12-15.2 (-19.2) x 1.6-2.4 μm , 1-septatae, hyalinae, laeves, cellula omnis biguttulata, in asco congestae. Aliquot periphyses breves adsunt.

HOLOTYPE: U.S.A. NEW MEXICO: Lincoln County, Valley of Fires, U. S. Hwy 380, along roadside, 28 October 1998, in foliis emortuis *Dasyllirion leiophyllum* Engelm., a Annette Ramaley n. 9815A lectus in BPI depositus.

Ascomata superficial, often in small groups, atop stromata of appressed, brown hyphae, globose, 36-60 (-72) μm diam., usually pale brown, setose, ostiolate. Peridium thin, composed of 1 (-2) layers of compressed, brown-walled cells externally, outermost layer of *textura epidermoidea* though its presence is often obscured by pigment deposition, and 1-2 layers of compressed, hyaline cells internally; bearing 4-8 setae each up to 50 μm long, pointed, brown, thick-walled, usually aseptate, occasionally with a septum near the swollen base. Asci unitunicate, 19.2-22.4 x 6.4 μm , ellipsoid to short oblong, 8-spored. Ascospores cylindric-fusoid, ends rounded, 12-15.2 (-19.2) x 1.6-2.4 μm , 1-septate, hyaline, smooth-walled, each cell biguttulate, crowded in the ascus. A few short periphyses present.

The minute, superficial, brown, setose ascomata with *textura epidermoidea*, unitunicate asci, and hyaline, 1-septate ascospores suggest placement in this family and genus. A few ascomata of this species were observed on leaves of *Nolina micrantha* as well as the *Dasyllirion* substrate.

Ascomata of *Niesslia agavacearum* are usually in small groups atop appressed, brown, hyphal stromata that may cover large areas of the leaves on which the ascomata appear. Hyphae extending from the walls of ascomata are pale brown, 1.6-2.4 μm diam. with septa up to 16 μm apart. Hyphae of the stromata are variable, but typically have sculptured walls that are much darker colored, broader, and shorter than the hyphal cells extending from the ascomata. It has not been possible to determine the relationship between the *Niesslia* ascomata and the extensive hyphal stromata, but *N. agavacearum* has never been observed apart from the stromata. All trials to cultivate *Niesslia agavacearum* were unsuccessful.

Niesslia is a widespread genus with eight species which have been examined recently enough to be described or redescribed in terms allowing comparison with *N. agavacearum*. Gams descriptions (1971) of *N. exosporioides*, *N. exigua*, *N. exilis* (Albertini & Schwein.) G. Wint., and *N. coloradensis* (Cash & Davidson) W. Gams separate these four species from *N. agavacearum*. Ascospores of *N. exigua* and *N. coloradensis* are ellipsoid, and for both species shorter than *N. agavacearum*

ascospores (7.0-8.5 μm vs 12-15.2 μm). The length of ascospores of *N. exilis*, the type species, approaches that of *N. agavacearum* ascospores, but *N. exilis* asci are longer and narrower (30-50 x 3-5 μm vs 19.2-22.4 x 6.4 μm), and the ascospores are uni- to biseriate within an ascus rather than crowded as they are in asci of *N. agavacearum*. *Niesslia exosporioides* is much like *N. exilis*, but the few setae may be up to 100 μm long vs. 30-50 μm for *N. exilis* setae. *Niesslia palmicola* (Hyde *et al.* 1999) ascospores are as long as ascospores of *N. agavacearum*, but those of *N. palmicola* are broader (10-15 x 2.5-4 μm vs 12-15.2 x 1.6-2.4 μm). In addition, *N. palmicola* ascomata bear hyaline hairs expanded at the tips rather than pointed, brown setae. Information provided by Barr (1993) for *N. erysiphoides* (Ellis & Everh.) Barr and *N. lanea* (Dearness) Barr distinguishes these species from *N. agavacearum*. *Niesslia erysiphoides* ascospores are larger than those of *N. agavacearum* (16.5-25 x 2-3 μm vs 12-15.2 x 1.6-2.4 μm), the asci are larger (33-44 x 7.5-9 μm vs 19.2-22.4 x 6.4 μm), and the ascomata are found in a thin, brown subiculum, not on an appressed, brown, hyphal stroma. *Niesslia lanea* is comparable to *N. exilis*, but the ascospores are relatively broad. *Niesslia pulchriseta* (Peck) Barr has small ascospores (5.5-7.5 x 1-1.5 μm) and huge setae (Barr *et al.* 1986). In addition to these characters, the minute ascomata of *N. agavacearum* distinguish it from all other species. *Niesslia agavacearum* is therefore designated a new species of the genus.

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THREE NOTEWORTHY AMANITAE OF SUBGENUS
LEPIDELLA FROM CHINA*ZUO-HONG CHEN¹, ZHU-LIANG YANG^{2,**} and ZHI-GUANG ZHANG¹¹College of Life Sciences, Hunan Normal University, Changsha 410081, China²Kunming Institute of Botany, Academia Sinica, Kunming 650204, China

Abstract: Three species of the genus *Amanita* with amyloid spores from China are described and illustrated. They are *A. sinocitrina*, *A. kotohiraensis*, and *A. gymnopus*. The first species is new to science, while the second is new for China. The last taxon is reported based on a collection with a double annulus on the stipe.

Key words: taxonomy, Amanitaceae, new species

While studying the Chinese species of *Amanita*, we have found three noteworthy taxa. They are reported herein. Color codes of the form "3B3" are from Kornerup & Wanscher (1981); Color names with first letters capitalized (e.g., Deep Olive-Buff) are from Ridgway (1912).

1. *Amanita sinocitrina* Z. L. Yang, Z. H. Chen & Z. G. Zhang, sp. nov. FIGS. 1-4

Pileus 4-6 cm *latus*, *convexus vel plano-convexus*, *griseo-flavus*, *interdum brunneolus*; *marginē non striata, non appendiculata*; *reliquiis volvae coactis, verrucosis vel flocculosis, applanatis, tenuibus, griseis vel brunneis ornatus*. *Lamellae liberae, albae vel albidae, confertae, lamellulis attenuatis*. *Stipes* 6-9 × 0.5-1 cm, *subcylindricus vel sursum attenuatus, albidus, annulatus, bulbo subtruncato vel truncato, marginato, 1.5-2.5 cm lato, volvae griseis vel brunneolis, verrucosis, flocculosis vel breviter limbatis*. *Annulus membranaceus, albidus vel cremeus vel subflavus supra, albidus vel griseolus vel brunneolus infra*. *Caro alba, sed tarde brunnescens*. *Basidia* 25-35 × 8.5-10.5 μm, *4-sporigera*. *Sporae* (5.5-) 6.0-7.5 (-8.0) × (5.0-) 5.5-7.0 (-7.5) μm, *globosae vel subglobosae, amyloideae*. *Fibulae absentes*. *Holotypus*: Z.H. Chen 3691 (HKAS 36983), 24. VI. 1997, Yizhang, Hunan, China.

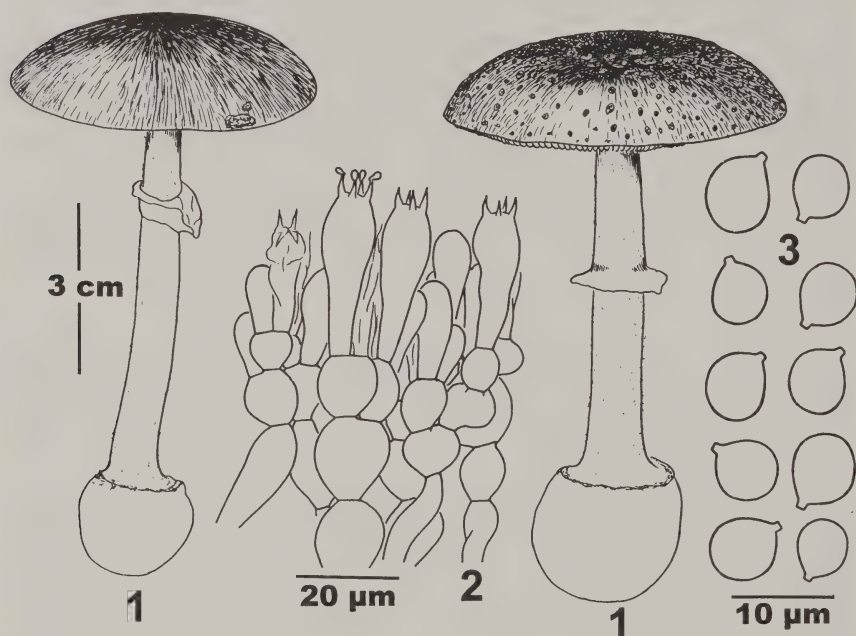
Etymology: *sinocitrina* is named for the Chinese mushroom because of its similarity to *A. citrina* originally described from Europe.

Basidiocarps small to medium-sized (fig. 1). **Pileus** (3-) 4-6 cm in diameter, convex to plano-convex, grey-yellow [3B3-6, 3C4-5; Deep Olive-Buff, Dark Olive-Buff], sometimes brownish [5C4-6], with indistinct, innate, radial fibrils; volval remnants as felty, verrucous to floccose patches, 2-5 mm wide, ca. 1 mm thick, grey to brownish, randomly arranged, often washing off in wet weather; margin smooth, non-appendiculate. **Lamellae** free, white to pale cream-colored,

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crowded; lamellulae attenuate, evenly distributed. **Stipe** 6–9 × 0.5–1 cm, subcylindric or somewhat tapering upward, with apex slightly expanded, white to dirty white, covered with yellowish squamules above annulus, with whitish to greyish squamules or fibrils under annulus; basal bulb subabrupt to abrupt, marginate, 1.5–2.5 cm wide, upper margin covered with greyish to brownish, verrucous to floccose volval remnants, sometimes submembranous and forming a brief limb around bulb margin. **Annulus** persistent, superior to nearly medium, membranous, whitish to cream-colored or pale yellowish on upper surface, whitish to greyish or brownish on lower surface. **Trama** white, very slowly turning brownish when exposed, especially in the bulb. **Smell** unknown.



Figs. 1–3: *Amanita sinocitrina* (HKAS 36983, holotype).

1. Basidiocarps; 2. Hymenium and subhymenium; 3. Basidiospores.

Lamellar trama bilateral. **Mediostratum** 30–40 μm wide, composed of abundant fusiform to long ellipsoid, inflated cells (60–90 × 20–25 μm), mixed with fairly abundant to abundant, filamentous hyphae, 2–7 μm wide; vascular hyphae rare. **Lateral stratum** composed of fairly abundant to abundant fusiform to long ellipsoid, inflated cells (55–100 × 15–20 μm), mixed with fairly abundant to abundant filamentous hyphae, 3–8 μm wide, diverging at an angle of ca. 30°–45° to the mediostratum; septa without clamps. **Subhymenium** (fig. 2) 30–40 (–50) μm thick, with 2–3 (–4) layers of subglobose to ovoid to short ellipsoid, inflated cells, 8–25 (–30) × 7–20 (–25) μm, occasionally mixed with barely inflated elements, 3–7

μm wide. **Basidia** (fig. 2) [130/6/5]¹ (20–) 25–35 (–40) $\times$ (8.0–) 8.5–10.5 (–11.5) μm , clavate, 4-spored, rarely 1- or 2-spored; sterigmata 3–5 μm long; basal septa without clamps. **Basidiospores** (fig. 3) [135/6/5]² (5.5–) 6.0–7.5 (–8.0) $\times$ (5.0–) 5.5–7.0 (–7.5) μm [$Q = 1.0\text{--}1.15$ (–1.20), $Q = 1.08 \pm 0.05$], globose to subglobose, rarely broadly ellipsoid, amyloid, colorless, hyaline, thin-walled, smooth; apiculus small. **Lamellar edge** appearing as sterile, somewhat gelatinized, incomplete strip, 30–70 μm wide in side view, composed of very abundant, globose to subglobose or ovoid (20–40 $\times$ 15–30 μm) to ellipsoid (35–50 $\times$ 20–30 μm), sometimes sphaeropedunculate (30–50 $\times$ 15–30 μm) inflated cells, single and terminal, or in chains of 2–3 and terminal, thin-walled, colorless, hyaline to subhyaline, mixed with scattered to fairly abundant, filamentous hyphae, 2–6 μm wide, thin-walled, gelatinized. **Pileipellis** 40–90 μm thick; upper layer 20–50 (–70) μm thick, strongly gelatinized, composed of subradially and loosely arranged, gelatinized, filamentous hyphae 1–5 μm wide, thin-walled, colorless, hyaline; lower layer (20–40 μm thick) composed of radially and compactly arranged hyphae 3–10 (–12) μm wide, subhyaline, colorless or with brownish vacuolar pigments, with terminal cells not distinctly inflated; vascular hyphae rare. **Volval remnants** (fig. 4) on pileus composed of irregularly arranged elements; inflated cells very abundant, globose to subglobose to ovoid (20–80 $\times$ 20–60 μm) or ellipsoid (40–60 $\times$ 25–30 μm), single and terminal, or in chains of 2–3 and terminal, thin- to slightly thick-walled (up to 0.5 μm thick), colorless, hyaline, colorless or with brownish to greyish, vacuolar pigments; filamentous hyphae fairly abundant to abundant, 2–7 μm wide, frequently septate, thin-walled, colorless, hyaline or occasionally with brownish to brown, vacuolar pigments; vascular hyphae rare. Volval remnants on upper margin of bulb on stipe base similar to those on pileus, but with filamentous hyphae somewhat more abundant. **Stipe trama** composed primarily of longitudinally arranged, long clavate, terminal cells, 250–400 $\times$ 25–40 μm , mixed with scattered (in interior) to fairly abundant to abundant (on stipe surface) filamentous hyphae 2–8 (–12) μm wide; vascular hyphae rare. **Annulus** composed of subradially arranged, filamentous hyphae 2–5 (–8) μm wide, thin-walled, colorless, hyaline to subhyaline, frequently branching, anastomosing; inflated cells rare, clavate to fusiform (25–45 $\times$ 9–12 μm), thin-walled, hyaline to subhyaline, almost colorless, usually single and terminal; vascular hyphae rare.

Specimens examined: CHINA. HUNAN PROVINCE: Yizhang County, Mangshan, alt. 900 m, 24-VI-1997, Z.H. Chen 3691 (HKAS 36983, holotype!); same location, alt. 1200 m, 27-VII-1997, Z.H. Chen 3712 (HKAS 36982); same location, alt. 900 m, 24-VI-1997, Z.H. Chen 3690 (HKAS 36981); same location, 29-IX-1981, Y. C. Zong & X. L. Mao 65 (HMAS 42248, as *A. porphyria* in Mao *et al.*, 1986); same location, 27-IX-1981, X. L. Mao & Y. C. Zong 20 (HMAS 52613, as *A. porphyria* in Mao *et al.*, 1986).

Habitat and Distribution: on ground in mixed forests. Only known from central China.

¹ 130 mature basidia from 6 basidiocarps of 5 collections measured in 5% KOH solution.

² 135 spores from 6 basidiocarps of 5 collections measured in 5% KOH solution; Q is used to mean "length/width ratio" of a spore; Q means average Q of all spores $\pm$ sample standard deviation.

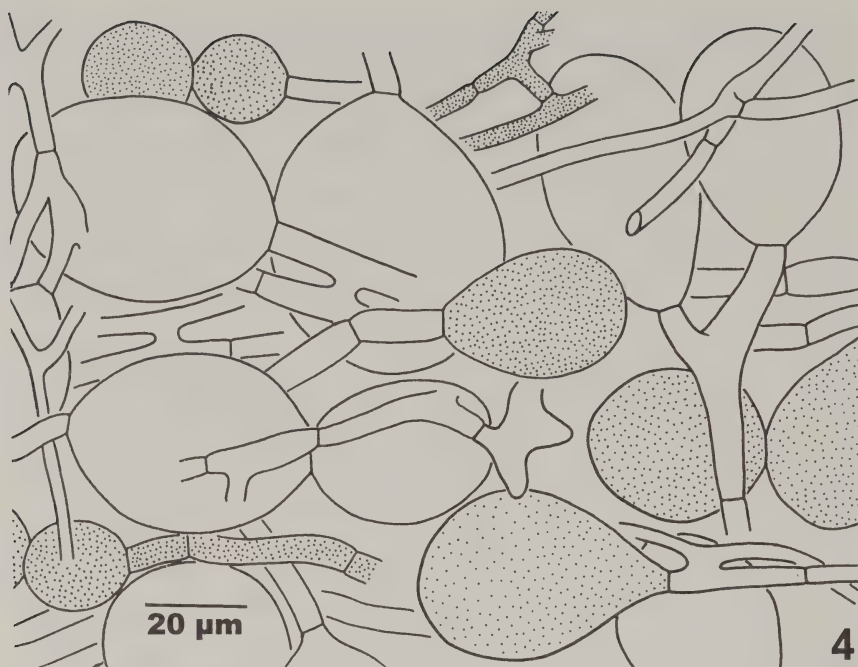


Fig. 4: Crushed volval remnants from pileus of *Amanita sinocitrina* (HKAS 36983, holotype).

Observations: *Amanita sinocitrina* belongs in *Amanita* subgenus *Lepidella* section *Validae* (Fr.) Quél. in the sense of Yang (1997). It is characterised by its small to medium-sized basidiocarp with a grey-yellow pileus, grey to brownish volval remnants, a whitish to yellowish annulus, a subabrupt to abrupt, marginate bulb on the base of the stipe, small basidia and spores. *Amanita sinocitrina* is related to members around *A. citrina* (Schaeff.) Pers. However, *A. sinocitrina* differs from *A. citrina*, originally described from Europe, by its differently colored pileus with somewhat darker colored volval remnants, smaller basidia and significantly smaller spores (Breitenbach & Kränzlin, 1995: 146; and unpublished data of Yang studying material from Germany-HKAS 31449 and 31537). HMAS 42248 & 52613 were regarded as *A. porphyria* (Alb. & Schw.: Fr.) Fr. by Mao *et al.* (1986). But *A. porphyria* differs from *A. sinocitrina* in its differently colored pileus and annulus, larger (longer and wider) basidia, and significantly larger spores (Breitenbach and Kränzlin, 1995: 152). Furthermore, the inflated cells in the volval remnants on the pileus of *A. sinocitrina* are more abundant than those of *A. porphyria* as compared with material of the latter collected from Germany-HKAS 31531, which has spores measuring $[30/1/1]$ $(7.5-8.5-10.0 (-10.5) \times (7.0-8.0-9.5 (-10.0) \mu\text{m})$ [$Q = 1.0-1.07 (-1.09)$, $Q = 1.04 \pm 0.03$], and basidia $[30/1/1]$ measuring $35-53 \times 9.5-12.0 (-13.0) \mu\text{m}$.

Amanita sinocitrina is also similar to *A. citrina* var. *grisea* (Hongo) Hongo, *A. citrina* f. *lavendula* (Coker) Vesely, *A. brunnescens* Atk. var. *brunnescens*, *A.*

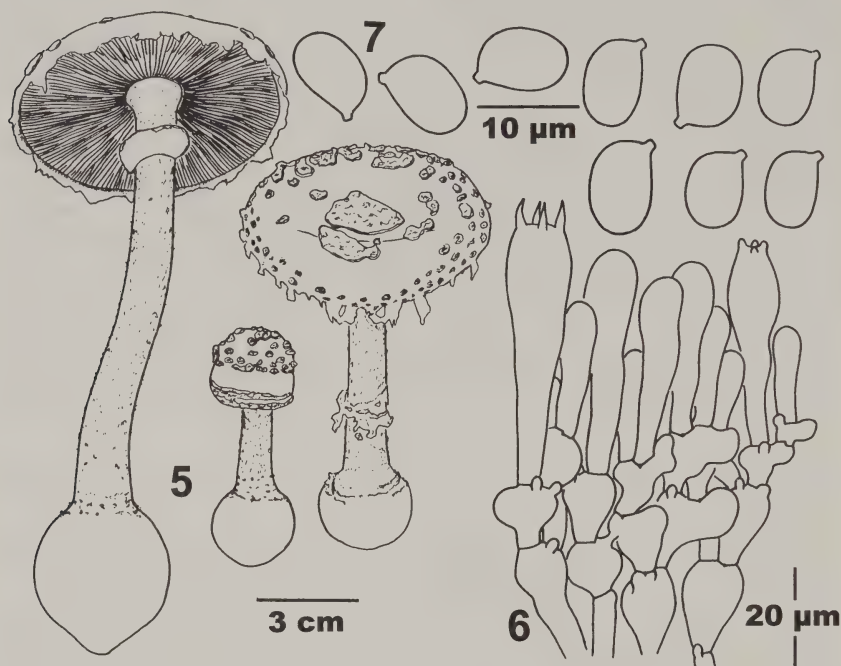
brunnescens var. *pallida* Krieger, *A. brunnescens* f. *straminea* E. J. Gilb., *A. aestivalis* Singer ex Singer and *A. asteropus* Sabo ex Romagn. Nevertheless, *A. citrina* var. *grisea*, described from Japan, has a darker colored pileus, pallid yellow annulus, larger basidia and larger spores (Hongo, 1958). *Amanita citrina* f. *lavendula*, originally described from the United States, is distinguished from *A. sinocitrina* by, among others features, its differently colored pileus with lavender volval remnants and somewhat smaller spores. *Amanita brunnescens* from eastern North America usually has larger basidiocarps with umbrinous brown, innate radial striations or fibrils on the pileus covered with whitish to pallid volval remnants, a white stipe with a usually longitudinally cleft bulb, longer basidia, and larger spores (Tulloss *et al.*, 1995; Jenkins, 1986). *Amanita brunnescens* f. *straminea* E. J. Gilb. has a differently colored pileus and stipe, and larger spores (Gilbert, 1941). *Amanita brunnescens* var. *pallida* and *A. aestivalis*, both described from eastern North America, have a paler colored pileus, a longitudinally splitting bulb, larger basidia and larger spores (Tulloss *et al.*, 1995; Jenkins, 1986). *Amanita asteropus*, described from Europe, has a differently colored pileus with differently colored volval remnants, and without innate, radial fibrils, a longitudinally splitting bulb, trama or surface of stipe turning rapidly brown-orange when injured, and larger spores (Tulloss & Massart, 1998).

2. *Amanita kotohiraensis* Nagasawa & Mitani, Mem. Natn. Sci. Mus., Tokyo 32: 93, Figs. 1–7 (2000). FIGS. 5–8

Basidiocarps small to medium-sized (fig. 5). **Pileus** (3–) 5–8 cm in diameter, convex to applanate, sometimes slightly depressed at disc, white, but sometimes cream-colored over disc; volval remnants as felty to verrucous patches, 2–4 (–15) mm wide, 1–1.5 mm thick, white, randomly arranged, sometimes nearly completely glabrous (volval remnants washed off by rain?); margin smooth, appendiculate. **Lamellae** free, yellowish to pale yellow, crowded; lamellulae attenuate, evenly distributed. **Stipe** 6–13 × 0.5–1.5 cm, subcylindric or usually tapering upward, with apex slightly expanded, white, often covered with white squamules or fibrils especially towards the stipe base; basal bulb subglobose, 1.5–4 cm wide, upper part covered with white, subgranular to verrucous or subconical volval remnants, irregularly arranged or in incomplete concentric rings. **Annulus** superior to subapical, pendant from attachment 1–2.5 cm below apex of stipe, white, finely and radially striate above, membranous, sometimes shredding or torn from stipe during basidiocarp expansion and then fugacious. **Trama** white, unchanging. **Smell** unpleasant, even when dried.

Lamellar trama bilateral. **Mediostratum** 30–40 µm wide, composed of fairly abundant to abundant subfusiform to long ellipsoid, inflated cells (90–110 × 15–20 µm), mixed with abundant, filamentous hyphae 2–5 µm wide, often clamped; vascular hyphae rare. **Lateral stratum** composed of fairly abundant to abundant fusiform to long ellipsoid, inflated cells (55–90 × 10–25 µm), mixed with abundant filamentous hyphae 2–7 µm wide, often clamped, diverging at an angle of (30°–) 45°–60° to the mediostratum. **Subhymenium** (fig. 6) 30–40 µm thick, with 2–3 layers of subglobose to ellipsoid or irregularly formed, inflated cells, 9–27 × 8–15 µm, sometimes mixed with barely inflated elements, 5–7 µm wide; septa usually clamped. **Basidia** (fig. 6) 35–50 × 8–13 µm, clavate, 4-spored, occasionally 2-

spored; sterigmata 3–5 μm long; basal septa usually with clamps. **Basidiospores** (fig. 7) [185/8/5] (7.0–) 7.5–9.5 (–11.0) $\times$ 5.0–6.5 (–7.0) μm [$Q = (1.21\text{--}) 1.27\text{--}1.60$ (–1.73), $Q = 1.44 \pm 0.10$], broadly ellipsoid to ellipsoid, rarely elongate, amyloid, colorless, hyaline, thin-walled, smooth; apiculus small. **Lamellar edge** appearing as



Figs. 5–7: *Amanita kotohiraensis* (HKAS 36995).

5. Basidiocarps; 6. Hymenium and subhymenium; 7. Basidiospores.

sterile, incomplete strip up to 120 μm wide in side view, composed dominantly of subglobose to broadly clavate or sphaeropedunculate, inflated cells (18–40 $\times$ 17–23 μm), single and terminal, sometimes in chains of 2–3 and terminal, thin-walled, colorless, hyaline, often clamped; filamentous hyphae rare. **Pileipellis** 70–100 μm thick; upper layer 30–50 μm thick, strongly gelatinized, composed of subradially arranged, filamentous hyphae up to 5 μm wide, gelatinized, thin-walled, colorless, hyaline; lower layer (40–50 μm thick) composed of subradially and compactly arranged hyphae 3–5 μm wide, hyaline to subhyaline, often clamped; vascular hyphae rare. **Volval remnants** (fig. 8) on pileus composed of (very) abundant, subglobose to ovoid (25–60 $\times$ 20–50 μm), sometimes ellipsoid (35–80 $\times$ 20–40 μm) inflated cells, single and terminal or in chains 2–3 and terminal, thin-walled, colorless, hyaline; filamentous hyphae fairly abundant to locally abundant, more abundant in volval remnant base than elsewhere, 2–7 μm wide, often clamped, frequently branching and anastomosing, interwoven, thin-walled, colorless, hyaline or sometimes with slightly yellowish contents; vascular hyphae rare, 2–7 (–10) μm wide. Volval remnants on upper part of basal bulb similar to those on pileus, but

with filamentous hyphae somewhat more abundant and inflated cells often in shorter chains. **Stipe trama** composed primarily of longitudinally arranged, long clavate, terminal cells, $280\text{--}400 \times 20\text{--}35\ \mu\text{m}$, mixed with scattered filamentous hyphae $1.5\text{--}7\ \mu\text{m}$ wide, often clamped; vascular hyphae rare. **Annulus** composed of abundant inflated cells, narrowly clavate to broadly clavate ($30\text{--}80 \times 10\text{--}25\ \mu\text{m}$), becoming broadly ellipsoid, ovoid to subglobose or sphaeropedunculate ($30\text{--}50 \times 15\text{--}35\ \mu\text{m}$) towards the upper surface, thin-walled, hyaline, often single and terminal; filamentous hyphae fairly abundant, $2\text{--}5\ \mu\text{m}$ wide, thin-walled, colorless, hyaline, frequently branching, anastomosing, often clamped; vascular hyphae rare.

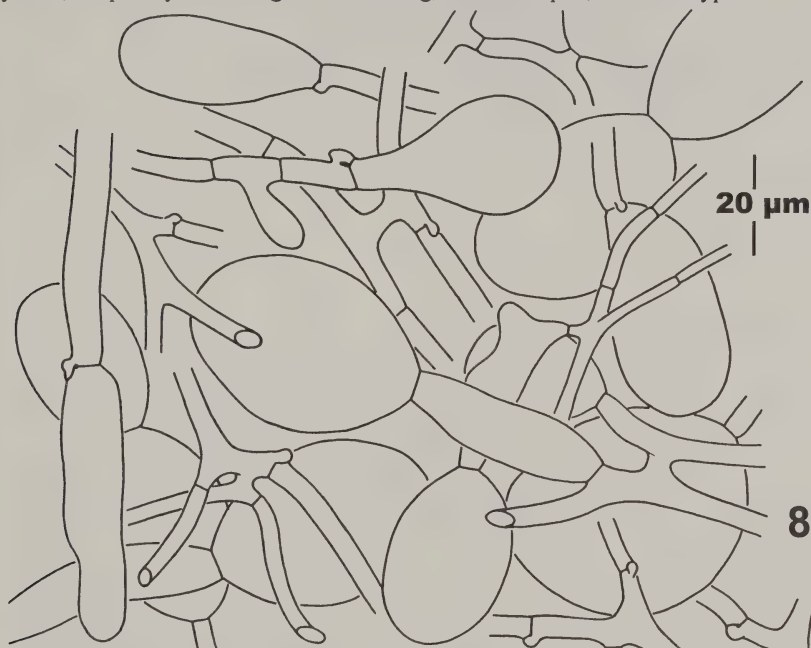


Fig. 8: Crushed volval remnants from pileus of *A. kotohiraensis* (HKAS 36996).

Specimens examined: CHINA. JIANGSU PROVINCE: Nanjing Municipality, Lingusi, 17-VIII-1957, S.C. Teng 4923b (HMAS 19941b). ANHUI PROVINCE: Huangshan Municipality, Huangshan, 30-VIII-1957, S.C. Teng 5150 (HMAS 20106). HUNAN PROVINCE: Yizhang County, Mangshan, alt. 900 m, 7-VII-2000, Z.H. Chen 3677 (HKAS 37051); same location, alt. 1200 m, 6-VII-2000, Z.H. Chen 4006 (HKAS 36996); same location, alt. 1200 m, 24-VII-1997, Z.H. Chen 3702 (HKAS 36995).

Habitat and Distribution: on ground in mixed forests. Described from Japan, and new to China.

Observations: The volval remnants on the pileus of the specimens cited above were rather difficult to analyse. They are probably composed of more or less irregularly arranged elements. But in the protologue of *A. kotohiraensis*, elements in the volval remnants on the pileus are described as perpendicularly oriented to the

pileus surface (Nagasawa & Mitani, 2000). Further observations on well-dried specimens are needed. *Amanita kotohiraensis* is representative of subsection *Solitariae* section *Lepidella* of the subgenus *Lepidella* (Bas, 1969). Nagasawa & Mitani (2000) suggested that it is closely related to *A. microlepis* Bas, described from the United States. But it differs from *A. microlepis* by its differently colored pileus and lamellae, and smaller spores. Furthermore, the volval remnants on pileus of *A. kotohiraensis* usually tend to be in patches rather than in warts as in *A. microlepis* (see Bas, 1969; Jenkins, 1986).

HMAS 19941b and 20106 were identified by S. C. Teng as *A. caesarea* var. *alba* Gillet and *A. verna* (Bull.: Fr.) Lamarck respectively. But *A. caesarea* var. *alba*, assignable to section *Caesareae* Singer ex Singer of subgenus *Amanita*, has a striate, non-appendiculate pileus only occasionally with volval remnants, truncate lamellulae, a firm and saccate volva on the stipe base lacking a bulb, and inamyloid spores. *Amanita verna*, belonging in section *Phalloideae* (Fr.) Quél., has a non-appendiculate pileal margin, a firm and membranous, limbate volva composed mainly of filamentous hyphae, distinctly larger spores, and lacks clamps.

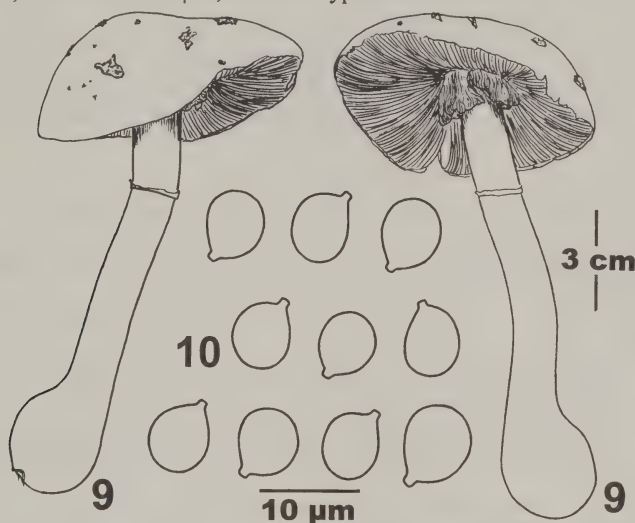
3. *Amanita gymnopus* Corner & Bas, Persoonia 2: 259, Pl. 4a, fig. 16 (1962)

FIGS. 9–10

Basidiocarps medium-sized to large (fig. 9). **Pileus** 6–9 cm in diameter, convex, becoming concave when over mature, white to cream-colored to brownish; volval remnants as yellowish to brownish, thin, submembranous, adnate patches, randomly arranged; margin smooth, appendiculate. **Lamellae** free, cream-colored to yellowish, then ochraceous, crowded; lamellulae attenuate, evenly distributed. **Stipe** 7–10 × 0.7–1.5 cm, subcylindric or slightly tapering upward, with apex slightly expanded, whitish to brownish, or with pinkish brown tinge; basal bulb broadly clavate to subglobose, 1.5–2.5 cm wide, white to dirty white, pruinose to subsquamulose near top, nearly glabrous below, without volval remnants, base often with a few rhizoids. **Annulus** apical to subapical, whitish to cream-colored, radially striate above, membranous to submembranous; with a smaller and firmer second annulus 2–3 cm apart from the apex. **Trama** white to cream-colored, but turning slowly brownish when exposed. **Smell** strong, of "sulphur".

Basidia 40–50 × 8–11 µm, clavate, 4-spored; sterigmata 4–5 µm long; basal septa often with clamps. **Basidiospores** (fig. 10) [30/1/1] 6.0–7.5 (–8.0) × (5.0–) 5.5–6.5 µm [$Q = 1.08\text{--}1.23$ (–1.34), $Q = 1.14 \pm 0.07$], subglobose to broadly ellipsoid, rarely ellipsoid, amyloid, colorless, hyaline, thin-walled, smooth; apiculus small. **Pileipellis** hardly differentiated, composed of ± radially arranged filamentous hyphae 2–5 µm wide, thin-walled, nearly colorless or with yellowish contents, not gelatinized or only the hyphae of upper part slightly gelatinized, sometimes clamped; vascular hyphae rare. **Volval remnants** on pileus composed of dominantly filamentous hyphae 2–5 µm wide, colorless and hyaline or sometimes with yellowish contents, sometimes clamped; inflated cells scattered, narrowly clavate to broadly clavate, sometimes ovoid to subglobose, 25–40 × 8–18 µm, single and terminal, sometimes in chains of 2–3 and then terminal, thin-walled, subhyaline or with yellowish contents; vascular hyphae rare. **Stipe trama** composed primarily of longitudinally arranged, long clavate, terminal cells, 250–400 × 25–35 µm, mixed with scattered filamentous hyphae 2–9 µm wide; vascular hyphae rare. **Annulus**

composed of abundant to very abundant inflated cells, ovoid to ellipsoid ($35\text{--}60 \times 20\text{--}40 \mu\text{m}$), sometimes subglobose ($25\text{--}40 \times 20\text{--}35 \mu\text{m}$), thin-walled, subhyaline or with yellowish to pale brownish contents, single or in chains of 2–3 and terminal; filamentous hyphae scattered to locally fairly abundant, $2\text{--}6 \mu\text{m}$ wide; vascular hyphae rare. The second annulus (the lower one) composed mainly of filamentous hyphae $2\text{--}6 \mu\text{m}$ wide; inflated cells rare, only locally (fairly) abundant, subglobose to ellipsoid, $20\text{--}60 \times 20\text{--}40 \mu\text{m}$; vascular hyphae rare.



Figs. 9–10: *Amanita gymnopus* (HKAS 37012).

9. Same basidiocarp in two views; 10. Basidiospores.

Specimen examined: CHINA. HUNAN PROVINCE: Yizhang County, Mangshan, alt. 600 m, 15–VII-1996, Z.H. Chen 3680 (HKAS 37012).

Habitat and Distribution: on ground in mixed forests. Described from Malaysia, and also reported from Japan, and China.

Observations: *Amanita gymnopus* was first reported from Fujian Prov., southeast China by Huang (1998: 135) but only with a very brief description. The collection cited above agrees well with the original concept of *A. gymnopus* (Corner & Bas, 1962; Bas, 1969) except that the stipe bears a second annulus, a feature probably not consistent in the species, because fruitbodies both with and without a second annulus of this taxon have been observed (see Hongo, 1974; Imazeki *et al.*, 1988; Hongo & Izawa, 1994). Bas (1969: 558) interprets the second annulus as (part of) the *limbus internus* in *A. ochrophylla*. This interpretation needs to be verified in the future. *Amanita ochrophylla* (Cooke) Clé., described from Australia, is closely related to *A. gymnopus*, but the former differs from the latter by its stipe without rhizoids, different structure of the volval remnants on the pileus, and significantly larger spores (Bas, 1969; Reid, 1980; Wood, 1997). According to Reid (1980), and Wood (1997), *A. ochrophyloides* Reid, and *A. ochraceobulbosa* Wood are closely related to *A. ochrophylla*. However, *A. ochrophyloides*, still not a well known

species, is distinguished from *A. gymnopus* by, among other features, its strobiliform volval remnants with different structure on a pale brown pileus, pale golden yellow lamellae, a short limbate volva on the bulb, and larger spores (Reid, 1980). *Amanita ochraceobulbosa* differs from *A. gymnopus* by its verrucous, conical to pyramid volval remnants on the pileus composed mainly of inflated cells, white to cream lamellae, and significantly larger spores (Wood, 1997). The question may still be open whether *A. ochrophyllodes* and *A. ochraceobulbosa* are closely related to *A. ochrophylla* or *A. gymnopus*.

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STUDIES IN NEOTROPICAL POLYPORES 13 CERIPORIOPSIS CYSTIDIATA SP. NOV.

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ABSTRACT

Ceriporiopsis cystidiata is described as new and characterized by a whitish to cream resupinate basidioma, a monomitic hyphal system and smooth, thin-walled hymenial cystidia. A key to *Ceriporiopsis* species in the neotropics is provided.

Key words: Polyporaceae, tropical America.

INTRODUCTION

Ceriporiopsis was described by Domanski (1963) to accommodate species with a resupinate, mostly light-coloured basidioma, a monomitic hyphal system with clamped generative hyphae and smooth, basidiospores without reaction in Melzer's reagent. All species produces a white rot in the attacked wood. It is a cosmopolitan genus, and 26 names are registered in the genus (CBS database: www.cbs.knaw.nl) out of which a number have later been transferred to other genera. The genus is by all probability artificial including species with different phylogenetic origin, kept together only by a simple construction. Further DNA studies must be done to reveal the phylogenetic affiliations of species currently kept in the genus.

Presence of cystidia has hitherto not been known in the genus, but recently Ryvarden (2000) described *Ceriporiopsis obscurus* Ryvarden based on specimens from Africa where thin-walled and smooth cystidia were present in the hymenium. Otherwise the species was characterized by a deep reddish colour, thin-walled and angular pores 4.5 per mm and ellipsoid basidiospores 4.5-5 x 2.5-3.5 µm and without reaction in Melzer's reagent.

The mycota of the neotropics is still not well known and recently a Brazilian straw-coloured resupinate polypore came to us for identification. A microscopical examination revealed it to be a *Ceriporiopsis* species in having the general characters outlined above. However, cystidia were present in the hymenium making it the second species in the genus with this character. The Brazilian collection, in contrast to *C. obscurus*, has a whitish basidiocarp, longer basidiospores and larger pores, even if the type of cystidia in both species were rather similar.

A key to the known neotropical species of the genus gave no clue to its identity, neither did other mycotas such as Gilbertson & Ryvarden (1986-87), Ryvarden & Gilbertson (1993-94), Núñez & Ryvarden (2000), Ryvarden & Johansen (1980). Apparently the species does not have a name and its is described below. A key to *Ceriporiopsis* in the neotropics with the new species is provided.

MATERIAL AND METHODS

Basidiomata were studied according to the methodology of Loguercio-Leite & Wright (1991). Colours are according to Munsell (1975) and herbaria abbreviations listed by Holmgren et al. (1990).

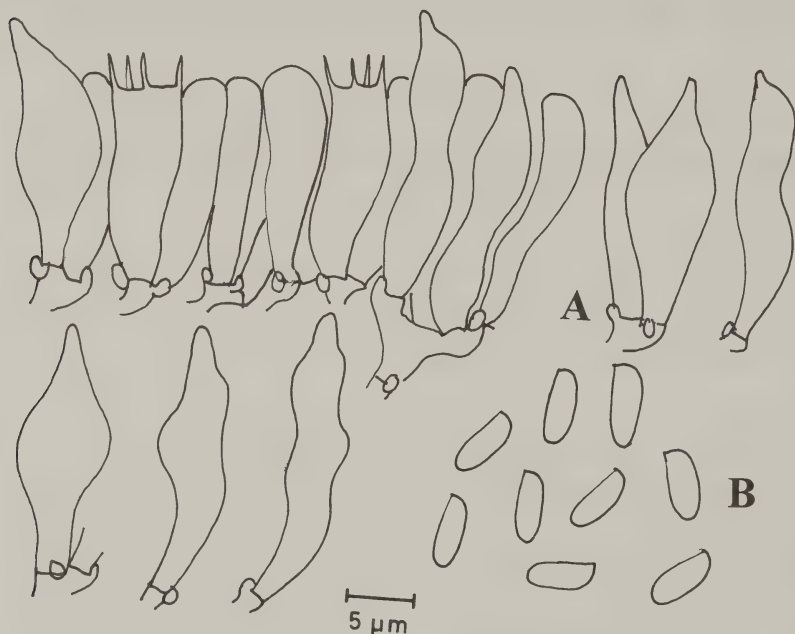


Fig. 1. *Ceriporiopsis cystidiata*, A) hymenium and cystidia, B) basidiospores. From the holotype.

Ceriporiopsis cystidiata Loguercio-Leite, G. V. de C. Gonc., Ryvarden nova sp. Fig 1
 Basidiocarpus annuus, resupinatus, niveus vel cremeus; poris angularis vel elongatus, 2-3 per mm, tubulis concoloribus mm; contextus tenuis, concoloribus; systema hypharum monomiticum, hyphis fibulatis, hyalinis, tenui-tunicatis vel crassi-tunicatis, 2-3 µm; cystidia laeves, tenuitincatae 10-15 x 4-8 µm; basidiosporis cylindricis, hyalinis, levibus, tenui-tunicatis, 5-6 (7) x 2.5-3.5 µm, inamyloideis.

Holotypus: Brasilia Insula Santa Catarina, Saco Grande (UCAD), leg. G. Gonçalves 1089, 30 IX 1997 in Herb. FLOR no 11894, conservatus est; isotypus in O .

Basidiocarpus annual, resupinate, fragile, margin whitish to pale tan when dry, pale brown (7.5YR 5/8), narrow, pore surface yellow (10YR 8/8, 7/6, 7/8) when dry, pores angular, with thin, entire dissepiments, 2-3 per mm; tubes concolorous with the pore surface, subiculum whitish, almost absent.

Hyphal system monomitic; subicular generative hyphae hyaline, thin- to slightly thick-walled, often branched, with abundant clamps, 2-3 μm in diam.

Cystidia present in the hymenium, smooth, clavate to slightly irregular, rounded or with a papillae 10-15 x 4-8 μm , occasionally with a few apical crystals.

Basidia clavate 4-sterigmate, 15-18 x 4-5, with a basal clamp.

Basidiospores cylindric, hyaline, smooth, distinctly apiculate, negative in Melzer's reagent, 5-6 (7) x 2.5-3.5 μm .

Substrata. Unknown hardwood tree.

Distribution. Known only from the type locality.

Remarks. The species is the only one in the genus from the American continent with smooth hymenial cystidia, thus it should be easy to recognize microscopically. As to basidiospores and pores, it reminds one of *C. resinascens* (Romell) Domanski of Europe (see Ryvarden & Gilbertson 1993:201), a non-cystidiate species with brownish basidiocarps because of resinous material. *C. gilvescens* (Bres.) Domanski, the type species, has smaller pores and spores, 4-5 per mm and 3.5-4.5 x 1.5-2 μm respectively.

KEY TO NEOTROPICAL SPECIES OF CERIPORIOPSIS

1. Pores 6-8 per mm..... 2
1. Pores large..... 3
2. Basidiospores allantoid, 3.5-5 x 1-1.2 μm *C. loweii*
2. Basidiospores ellipsoid, 3-3.5 x 2-3 μm *C. flavilutea*
3. Basidiospores 8-10 μm long..... *C. cernuata*
3. Basidiospores shorter..... 4
4. Pores irregular, up to 3 per mm becoming daedaleoid to sinuous..... 5
4. Pores more or less angular to round 6
5. Basidiospores 3-4 μm long, pores irpicoid to daedaleoid,
1-2 per mm..... *C. latemarginata*
5. Basidiospores 4-5 μm long, pores round to angular, in parts split,
2-3 per mm *C. balaenae*
6. Basidiospores subglobose..... 7
6. Basidiospores ellipsoid to cylindrical 8
7. Basidiospores 2.5-3.5 x 2-2.5 μm *C. mucida*
7. Basidiospores 5-6 x 4-5 μm *C. rivulosus*.
8. Smooth cystidia present, basidiospores cylindric,
5-6 x 2.5-3.5 μm *C. cystidiata*
8. Cystidia absent, basidiospores ellipsoid, 3.5-4.5 x 2.5-3 μm 9
9. Basidiospores slightly amyloid, pore surface white *C. myceliosa*
9. Basidiospores non-amyloid, pore surface pale brown *C. umbrinescens*

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NEW SPECIES OF AMANITA FROM THE DOMINICAN REPUBLICA, GREATER ANTILLES

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ABSTRACT

Three new species of *Amanita* are described from the Dominican Republic on the island of Hispaniola. One of the new species is in subgenus *Lepidella* section *Amidella* and two are in subgenus *Amanita*. One of the latter two species is in section *Amanita*, but the other cannot be placed below subgenus.

Key words: *Pinus*, Hispaniola.

¹The Forest Products Laboratory in Madison is maintained in cooperation with the University of Wisconsin, while the lab in Puerto Rico is maintained in cooperation with the USDA-Forest Service International Institute of Tropical Forestry. This article was written and prepared by a U.S. Government employee on official time, and the information is therefore in the public domain and not subject to copyright.

INTRODUCTION

The Island of Hispaniola, including the Dominican Republic, has a single native pine *Pinus occidentalis* Swartz which grows in extensive areas from about 850 to nearly 2500 m elev. which is the easternmost extent of native pine in the Caribbean. It is either scattered or in nearly pure stands. It has been planted in a few areas, but not extensively. Extensive natural populations of *P. occidentalis* occur on over 335,000 hectares throughout the mountains of Hispaniola (Darrow & Zandoni, 1993). It is a unique situation in that it is the only ectomycorrhizal conifer species throughout its range in the Dominican Republic with only very restricted additional distributions in Cuba. The new species reported in this paper have all been under or near *Pinus occidentalis* and are putatively ectomycorrhizal with it.

MATERIALS AND METHODS

Color comparisons made using Kernerup and Wanscher (1967) are designated Met. (e.g., Met 6E-4 indicates the plate, row, and color block). In some cases, pileus colors were recorded using Cailleux (1948) and are noted as Caill. (e.g., Caill. T73 indicates row T, color block 73). A few others were recorded as Ridgway (1912) color names as reproduced by Smithe (1975) and are given in capitalized form, e.g. (Drab Gray) and accompanied by Munsell color notations in parentheses (e.g., 0.1Y 6.8/2.1). Collection numbers preceded by CFMR DR- refer to a unique number in the database for the Basidiomycetes of the Greater Antilles project; ledger numbers are also presented, if assigned. Chemical reagents including Melzer's solution, Gum-guaiac, 2% Phenol, and Ferric sulphate were used for spot testing tissue samples when appropriate. Drawings were made from mounts in 3% KOH or Melzer's solution. Smell and taste were recorded when possible from fresh material. The E value is the length divided by the width of the basidiospore and the E_m value is the mean of E of $N = 31$ spores unless otherwise stated. For color images of several of the taxa described here see: <http://www.cortland.edu/NSF/ga.html>.

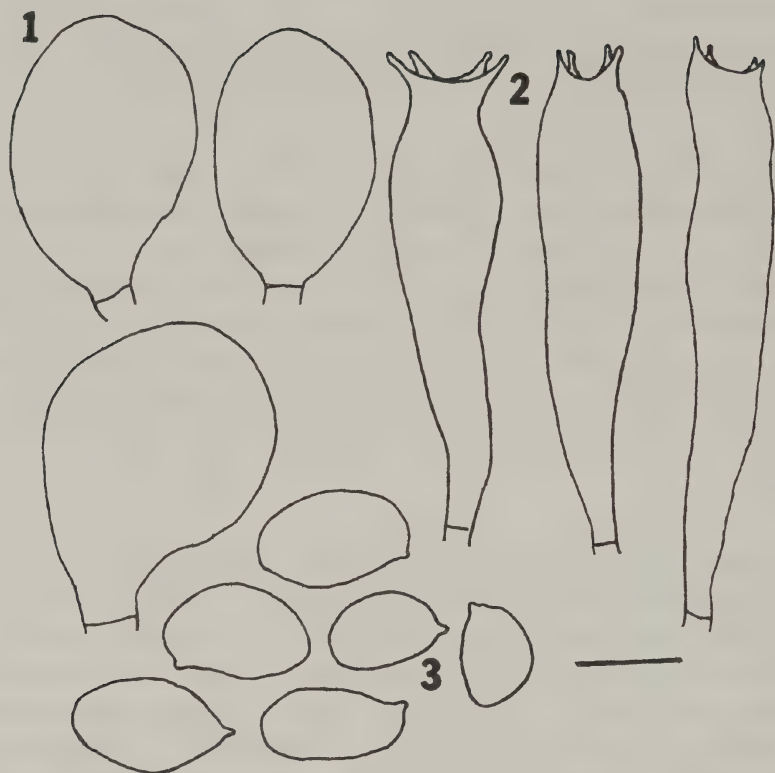
TAXONOMY

Amanita occidentalis O.K. Mill. & Lodge *sp. nov.* Figs. 1-3, 10-12, 15.

Pileus 45-65 mm latus, late convexus, siccus, pallide alutaceus in superficie reliquiis volvae universalis in maculis conspicuis albis vel sordide et pallide brunneolis ornatus, in margine obscure striatus. *Lamellae* fere liberae, modice latae, obscure albae, lamellulis sparsis, curtis. *Stipes* 48-100 mm longus, supra volvam (4-) 8-25 mm latus, in superfice fibrillis elevatis primo brunneolis aetate albescentibus ornatus; volva saccata, alba aetate colore brunneo tincta. *Contextus* mollis, in pileo atque stipite superiore albus, in parte inferiore colore bruno tinctus, in centro infirmus. Odor gratus sed non distinctus.

Pileipellis mixocutem formans, hyphis filamentosis 2.4-4.5 μm diam., in superficie intertextis vel fere rectis, tenuitunicatis, simplicis-septatis, in 3% KOH atque solutione Melzeri hyalinis vel luteolis reagentibus praedita. *Pileitrama* e hyphis tenuitunicatis, hyalinis, filamentosis atque cellulis interspersis, 2.7-44.0 μm diam., inflatis, tenuitunicatis composita. *Trama lamellaris* e hyphis divergentibus, tenuitunicatis, filamentosis atque cellulis 2.7-44.0 μm diam., subvesicularibus vel inflatis composita. *Basidia* 44-53 x 9.8 - 11.7 μm diam., longe clavata, tenuitunicata, hyalina, 4-spora. *Basidiosporae* (9-) 10-14 x 5.5-9.0 μm ($E_m = 1.68$; $E = 1.47-2.03$) late ellipticae, tenuitunicatae, in solutione Melzeri amyloideae. **Holotypus** sub Pinus occidentalis Republica Dominicana, La Vega Prov., Valle Nueva, 2200 m elev., O.K. & H.H. Miller & D. J. Lodge, OKM 27082 lectus.

Pileus 45-65 mm broad, broadly convex, moist, brownish orange, Tawny (5.0 YR 5.0/7.0) at the disc to Raw Sienna (7.5 YR 5.5/9.0) fading to pale orange with pinkish tint, Pale Pinkish Buff over the margin, light tan ground color with conspicuous white to sordid light orange brownish (Tawny Olive. 1.0 Y 5.2/4.5); patches of universal veil scattered over the surface; margin with short obscure striations. *Lamellae* nearly free, medium broad, dull white with scattered short lamellulae. *Stipe* 48-100 mm long, (4-) 8-25 mm wide above the volva,



Figures 1-3, *Amanita occidentalis*. Fig. 1. Cheilocystidia. Fig. 2. Basidia. Fig. 3. Basidiospores. Bar = 10 μm

enlarging to a clavate base, with raised brownish surface fibrils which are nearly white in age. *Annulus* superior, friable, disappearing with age. *Volva* saccate, white, tinted orange-brown in age. *Context* soft, white in cap and upper stipe, tinted brown below with a soft enteria *Odor* pleasant but not distinctive.

Pileipellis an ixomixocutis with filamentous hyphae 2.4–4.5 μm diam interwoven to nearly erect at the surface, thin-walled, simple septate, hyaline to yellowish in 3% KOH and Melzers solution. *Pileitrama* a combination of thin-walled, hyaline, filamentous hyphae interspersed with large inflated thin-walled cells 2.7–43.0 μm diam. *Lamellar trama* divergent, a combination of thin-walled filamentous hyphae and swollen

to inflated cells 2.7–44.0 μm diam. *Subhymenium* a textura intricata of cells 7–13 x 5–8.5 μm diam, thin-walled, hyaline and several cells thick. *Universal veil* in cross section reveals interwoven hyphae 4.2–15 μm diam, dense on the inner face with infrequent ovoid to swollen cells (up to 106 x 33 μm) toward the middle, thin-walled, simple septate, hyaline in 3% KOH. *Cheilocystidia* 25–27 x 17–22 μm , ovoid to globose, thin-walled, hyaline usually in a single layer. *Basidia* 44–53 x 8.0–11.7 μm diam long clavate, thin-walled, hyaline, 4-spored. *Basidiospores* (9–)10–14 x 5.5–9.0 μm ($E_m = 1.68$; $E = 1.47$ – 2.03), broadly elliptical, thin-walled, hyaline in 3% KOH and dark blue (amyloid) in Melzers solution.

Habit, habitat and distribution. On ground under pure *Pinus occidentalis* stand near the Fundación Moscoso Puello cabin at Valle Nuevo, 2200 m elev. Fruiting from November to January.

Material examined. Dominican Republic: La Vega Prov., Valle Nuevo, 21 Nov. 1997, 2200 m asl, coll. D.J. Lodge and O.K. and H.H. Miller OKM 27082 (HOLOTYPE) (CFMR DR-1250, JBSD 88204;); 30 July 1996, coll. D.J. Lodge CFMR DR-104 (CFMR; JBSD 88205).

Observations. The faint striations on the margin were not plicate-striate and were often incomplete. The volval coloration was difficult to judge on the old specimens, but it was orange-brown (apricot color) in DR-104, which was young material. In addition, the annular zone noted on the young specimens of DR-104 was not present in older specimens. A comparison of the volval tissue (Fig. 10), the spore shape and size, and the thick saccate volva (Fig. 15) leaves no doubt that both collections represent the same species in two different stages of maturity. Both fruitings occurred in the same area on the forested road mentioned above in January and again in November.

In the North American literature, this taxon would be in Section *Amidella* according to Jenkins (1986), and Subsection *Amidellae* (Gilb.) Drenth, Vilgalys & Moncalvo according to Drenth et al. (1999). Species in *Amidella* are characterized by a combination of friable volval remains on the pileus, lack of strong striations on the cap margin, broadly elliptical amyloid spores, and a saccate volva. The only species which seems close

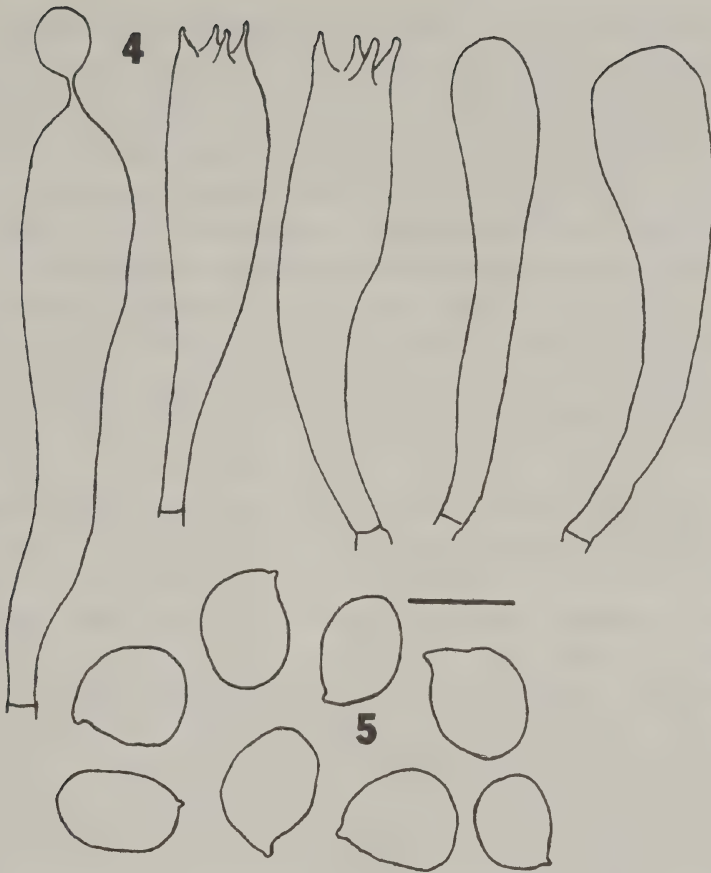
to *A. occidentalis* is *A. volvata* (Pk.) Lloyd but the spores of that species are smaller and narrower ($8.6\text{--}10.2 \times 5.5\text{--}7 \mu\text{m}$ with an $E_m = 1.48$) than in our taxon which is mostly $10\text{--}14 \times 5.5\text{--}9.0 \mu\text{m}$ with an $E_m = 1.68$.

***Amanita circinata* O.K. Mill. & Lodge sp. nov.** Figs. 4-5, 11-12, 16

Pileus 40-82 mm latus, convexus, ad marginem involutus, siccus, impolitus, subsericeus, rutilascens vel pallide aurantiacus vel carneus, verrucis bubalinis vel flavis pyramidalibus ornatus. *Lamellae* liberae, aggregatae, albae, lamellulis uniformibus praeditae, aequimarginatae. *Stipes* 55-95 x 12-22 mm, siccus, albus, ad basem bulbosus annulis concentricis pallide bubalescentibus vel ochraciusculis ornatus; annulus didymus, superior fibrosus, inferior membranaceus. *Pileipellis* ex hyphis laxae intertextis, filamentosis, tenuitunicatis $2.5\text{--}7.6 \mu\text{m}$ diam., in solutione 3 % KOH hyalinis, in solutione Melzeri luteolis reagentibus composita. *Pileitrama* e hyphis intertextis usque $18 \mu\text{m}$ diam. atque cellulis turgidis, irregularibus vel ovoideis in solutione KOH hyalinis, in Melzeri aurantiaci-brunneis reagentibus composita. *Lamellae* e hyphis divergentibus hyphis tramae similibus compositae. *Volva universalis* ex cellulis globosis vel plerumque ovoideis, tenuitunicatis $(18\text{--})22\text{--}55 \times (10\text{--})15\text{--}30 \mu\text{m}$ atque hyphis sparsis, filamentosis $2.5\text{--}7 \mu\text{m}$ diam immixtis composita. *Volva* $(9\text{--})12\text{--}27 \times (5.5\text{--})7\text{--}13 \mu\text{m}$ diam, partialis e cellulis ovoideis, fusiformibus vel irregulariter turgidis atque hyphis aequinumerosis, filamentosis $3\text{--}8 \mu\text{m}$ diam composita. *Basidia* $35\text{--}46 \times 8\text{--}10.5 \mu\text{m}$, clavata, tenuitunicata, 4-spora, hyalina. *Basidiosporae* $7.5\text{--}11.5 \times 6.5\text{--}8.5 \mu\text{m}$ ($E_m = 1.32$; $E = 1.15\text{--}1.46$) brevi-ellipticae vel subglobosae, tenuitunicatae, in solutione KOH atque Melzeri hyalinae reagentes.

Holotypus sub Pino occidental, Las Placetas, Santiago Prov., Republica Dominicana, 28 Jan. 1998, coll. D. J. Lodge, G. Dobler, M. Castellano, J. Trappe, J.G. Torres & R. Ferreras, Leg. Lodge DJL-43, CFMR DR-587 lectus.

Pileus 40-82 mm broad, convex with enrolled margin, pale Burnt Orange, Orange-Rufus (2.5 R 5.0/10.0) to Flesh Ochre (2.5 YR



Figures 4-5. *Amanita circinata*. Fig. 4. One and four spored basidia and basidioles. Fig. 5. Basidiospores. Bar = 10 μ m

6.6/8.0) with Buff-Yellow (2.5 Y 8.0/7.0) pyramidal warts, dry, dull and slightly silky. *Lamellae* free, white, 2 per mm; one length of lamellulae; edges even. *Stipe* 55-95 x 12-22 mm, white above ring, slightly felty. *Annulus* double, inferior, upper veil fibrous, white; lower veil membranous, white with a yellow margin. *Volval elements* over base as five to six Light Drab concentric rings on Drab Gray ground above; base clavate to sub-bulbous, slightly cleft, white. Odor not distinctive.

Pileipellis of loosely interwoven, filamentous, thin-walled hyphae

2.5–7.6 μm diam, hyaline in 3% KOH light yellow in Melzers solution. *Pileitrama hyphae* similar but larger, up to 18 μm diam, some swollen, irregular to ovoid cells, hyaline in KOH, orange-brown in Melzers solution (many hyaline cells but some pigment in cells and cell walls). *Lamellae* of divergent hyphae, similar to trama. *Universal veil* a combination of 50% globose to mostly ovoid thin-walled cells 9–24 $\times$ 7–14 μm intermixed with 50% filamentous hyphae 1.5–4 μm diam. *Annulus* a combination of ovoid, fusiform, to irregular swollen cells (9–) 12–27 $\times$ (5.5–)7–13 μm diam. and an even number of filamentous hyphae 1.5–4.5 μm diam. *Basidia* 35–38 $\times$ 10 μm clavate, thin-walled, 4-spored, hyaline. *Basidiospores* 7.5–11.5 $\times$ 6.5–8.5 μm ($E_m = 1.32$: $E = 1.15$ –1.46), subglobose, rarely globose, thin-walled, hyaline in Melzers solution and 3% KOH.

Habit, habitat, and distribution. Single or several on the ground under *Pinus occidentalis*, fruiting in January.

Material examined. Dominican Republic, La Vega Prov., above Manabao, Jose Cruz's farm, 19° 4' 46" lat., 70° 48' 11" long., 29 Jan. 1998; coll. D.J. Lodge, G. Dobler, M. Castellano, & J. Trappe, Leg. Lodge DJL-59, CFMR DR-603 (CFMR; JBSD 88663) (HOLOTYPE); Santiago Prov., Las Placetas, 1100 m elev., 19° 13' 27" lat., 70° 53' 27" long., 28 Jan. 1998, coll. D.J. Lodge, G. Dobler, M. Castellano, J. Trappe, DR-603. Santiago Prov., La Placeta, Jan. 28, 1998, D. J. Lodge, G. Dobler, M. Castellano. & J. Trappe, J.G. Torres & R. Ferreras, Leg. Lodge DJL-43, CFMR DR-587 (CFMR; JBSD 88204).

Observations. The persistent pyramidal warts on the pileus and 5-6 persistent rings over the clavate bulb (Fig. 16) make this taxon instantly recognizable when fresh or dried. The similar basal rings in *Amanita muscaria* are only 2 to 3 on the upper bulb. The non amyloid spores place it in the Subgenus *Amanita* section *Amanita*. A survey of the literature does not reveal a similar taxon in papers by Jenkins (1986), Pelger (1983, 1977), nor in Tulloss, Ovrebø, & Halling, (1992) or the various papers of Tulloss.

***Amanita cruzii* O.K. Mill. & Lodge sp. nov.** Figs. 6-9, 13-14, 17-18.

Pileus (30-)40-80 mm latus, conicus, convexus vel late convexus, siccus, in statu juvenili volva universali alba, tenui, exteriore praeditus, primo in tota superficie verrucis densis, albis, pyramidalibus in locis non profunde depressis dispositis ornatus, cito abrasus volvam interiorem, pulveraceam, ferrugineam (Met 6 C-D 7 usque Met 7 D6-7) superficiem totam cooperientem aperiens; color pilei pallide aurantiacus, ad marginem primo reliquiis sparsis volvae partialis. *Lamellae* liberae, modice latae, subdistantes, ad marginem minute fimbriatae, albae. *Stipes* 55-90 mm longus 4-13 (-20) mm latus, albus, bulbum basalem versus expansus 17-28 mm latus, supra bulbum annulis texturae elevatae atque in superficie reliquiis volvae universalis ferrugineis, pulveraceis praeditus. *Volva partialis* in apice stipitis evanescens, cito delapsa, in superficie inferiore ferruginea, pulveracea, in superiore alba, lamellis striatis praedita. *Contextus* firmus, albus, in dimidio inferiore stipitis in centro medullosus. *Odor* non distinctus vel leniter raphani vel *Solani tuberosi* L.

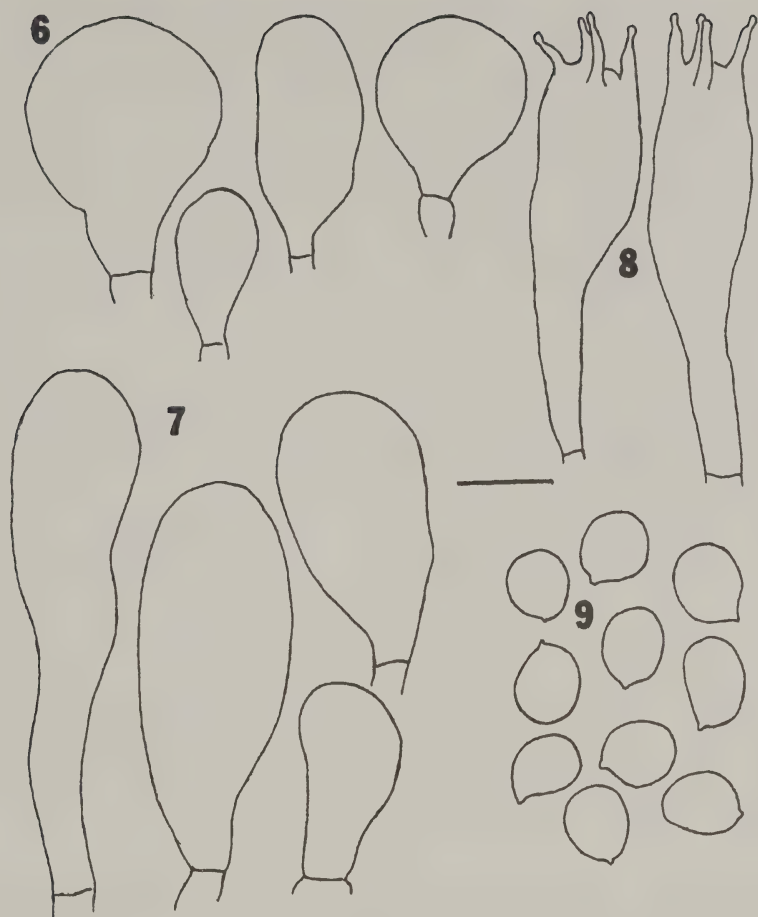
Pileipellis trichodermium e cellulis terminalibus, clavatis, capitatis, globosis vel irregularibus, 21-52 x 7-21 μm latis compositum formans, e subcute intertexta, filamentosa, tenuitunicata e hyphis hyalinis 3-6 μm diam composita exorientem. Trama lamellaris e hyphis divergentibus 3.4-11 μm diam, tenuitunicatis, hyalinis composita. *Volva universalis* tenuis. *Volva exterior* alba, verrucis pyramidalibus e cellulis ovoideis, ellipticis vel pyriformibus compositis ornata, hyphis sparsis, tenuitunicatis, filamentosis, 4-6.5 μm diam. praedita. *Volva interior* stratum pulveraceum, brunneum e cellulis ovoideis vel horizontaliter bicapitatis 19-49 x 10-26 μm diam atque hyphis filamentosis, hyalinis 1.7-4.0 μm compositum formans. *Volva partialis* e cellulis ovalis, ellipticis vel globosis, saepe horizontaliter bicapitatis, tenuitunicatis 19-49 x 10-26 μm diam atque hyphis filamentosis, tenuitunicatis, hyalinis 2-3.5 μm diam immixtis composita. *Cheilocystidia* 15-31 x 7.5-20 μm , pyriformia, clavata vel globosa, tenuitunicata, in 3% KOH hyalina reagentia. *Basidia* 43-45 x 10-12 μm diam, clavata, 4-spora. *Basidiosporae* 7-9 x 6-7 μm ($E_m = 1.26$; $E = 1.02-1.50$) subglobosae vel late ellipticae, hyalinae, tenuitunicatae, in solutione Melzeri non

amyloideae. Fibullae nullae

Holotypus in Re publica Dominicana, Santiago Prov., San Jose del Les Matas, La Celestina Project, Nov. 24, 1999, O.K. & H. Miller OKM 27706 lectus.

Pileus (30–) 40–80 mm broad, convex to broadly convex, dry; *universal veil* duplex, buttons have a thin, membranous, white outer layer with pyramidal white warts which are centered within shallow depressions, and are dense over the disc, soon sloughing off to reveal a powdery, rusty brown (Met 6 C–D 7 to Met 7D 6–7) inner veil which completely covers most surfaces; in age both veils give way to a smooth light orange (Met 6A2) ground color; in some specimens raised white squamules remain over the disc; margin at first with scant remains of the partial veil. *Lamellae* free, moderately broad, subdistant, white; with two lengths of lamellulae; margin minutely fimbriate. *Stipe* 55–90 mm long, 4–13 (–20) mm wide, expanding toward the basal bulb; *basal bulb* 17–28 mm wide, white with rings of raised volval tissue above the bulb, with even to patchy rusty brown powdery surface remnants of the inner universal veil. *Partial veil* duplex, located at stipe apex, evanescent, falls away or is appendiculate for a while; lower layer is composed of inner universal veil material, rusty brown and powdery as on the pileus surface, attached just at the apex; upper layer white, with lamellar striations, lacking powdery material. *Context* firm and white throughout except for the lower half of the stipe which is white and pithy in center. *Odor* indistinct, faint, resembling raddish or potato.

Pileipellus a loose trichodermium of clavate, capitate, globose to irregular terminal cell $21\text{--}52 \times 7\text{--}21 \mu\text{m}$, which arise from an interwoven, filamentous, thin-walled subcutis of hyaline hyphae $3\text{--}6 \mu\text{m}$ diam. *Pileitrama* of loosely interwoven hyphae $3.4\text{--}10$ (–24) μm diam, thin-walled and hyaline. *Lamellar trama* of divergent hyphae $3.4\text{--}11 \mu\text{m}$ diam, thin-walled, hyaline. *Clamp connections* lacking in all tissue.



Figures 6-9. *Amanita cruzii*. Fig. 6. Cheilocystidia. Fig. 7. Trichodermial cells of the pileipellis. Fig. 8. Basidia. Fig. 9. Basidiospores. Bar = 10 μm .

Universal veil duplex, thin, white outer veil with pyramidal warts, ovoid, elliptic to pear shaped cells 16–68 x 13–33 μm ($E_m = 1.58$; $E = 1.06$ –3.47) thin-walled, hyaline with scattered thin-walled, filamentous hyphae; inner veil a powdery brown layer of ovoid, rarely globose to dumbbell shaped, cells 19–49 x 10–26 μm diam [$E_m = 1.76$; $E = 1.0$ –3.1] intermixed with about 20% filamentous hyaline hyphae 1.7–4.0 μm in

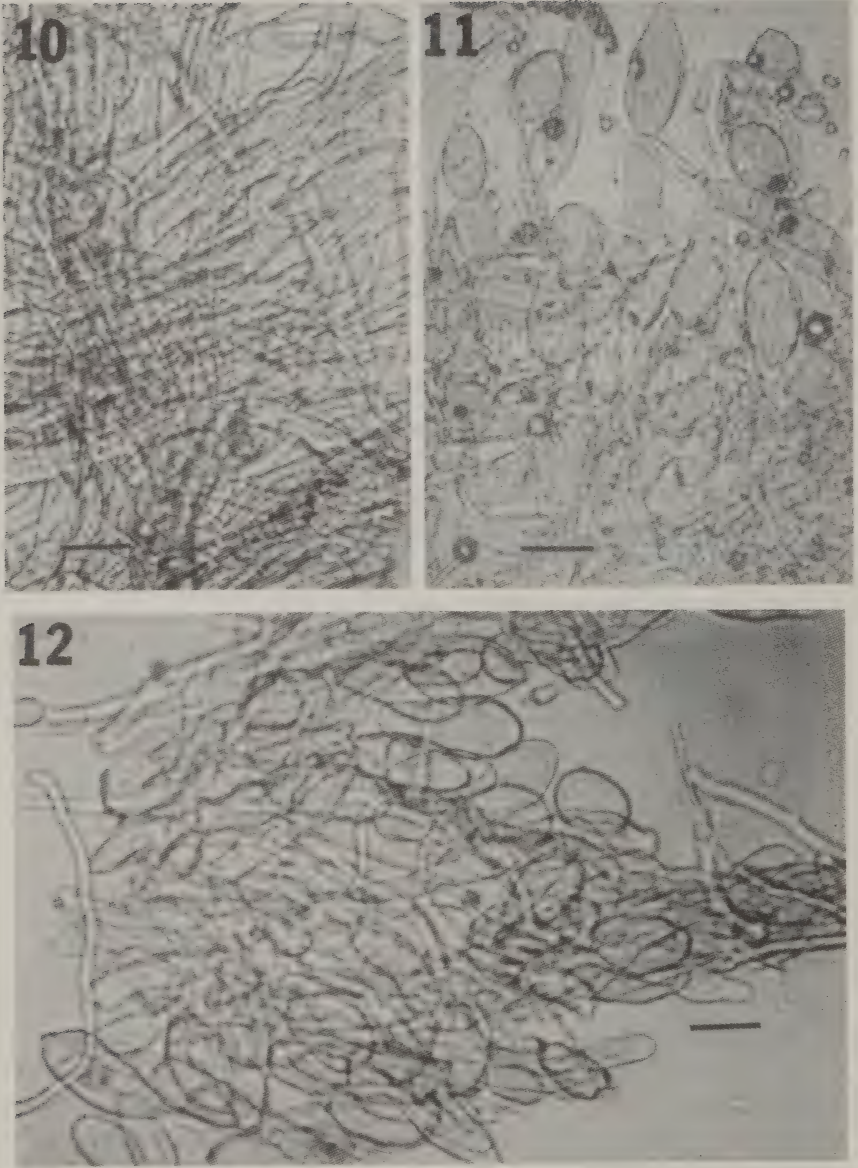
diam. *Partial veil* of oval, elliptical to globose, often dumbbell shaped, thin-walled cells $19\text{--}49 \times 10\text{--}26 \mu\text{m}$ diam [$E_m = 1.76$; $1.0\text{--}3.1$] intermixed with 45% filamentous, thin-walled, hyaline hyphae $2\text{--}3.5 \mu\text{m}$ diam, branched and simple septate in 3% KOH. *Cheilocystidia* $15\text{--}31 \times 7.5\text{--}20 \mu\text{m}$ wide, pyriforme, clavate, to globose, thin-walled, hyaline in 3% KOH. *Basidia* $43\text{--}45 \times 10\text{--}12 \mu\text{m}$, clavate, 4-spored, thin-walled, hyaline in 3% KOH. *Basidiospores* $7\text{--}9 \times 6\text{--}7.5 \mu\text{m}$ ($E_m 1.26$; $E = 1.02\text{--}1.50$) subglobose to broadly ellipsoid, hyaline, thin-walled, non-amyloid in Melzer's solution and hyaline to light yellow with a large central yellow oil body in 3% KOH.

Habit, habitat and distribution: single or several fruiting bodies under *Pinus occidentalis*, in mixed woods or plantations, La Vega and Santiago Provinces, Dominican Republic. Fruiting from November to January.

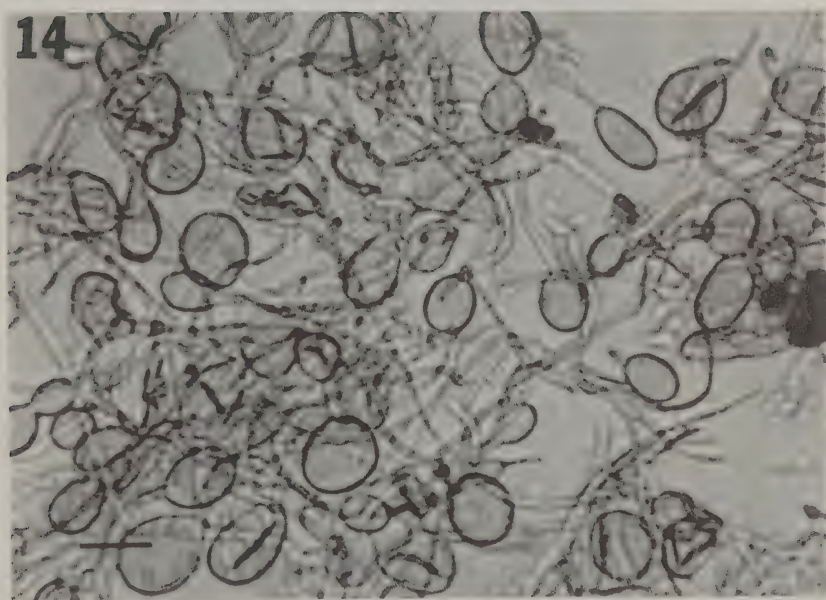
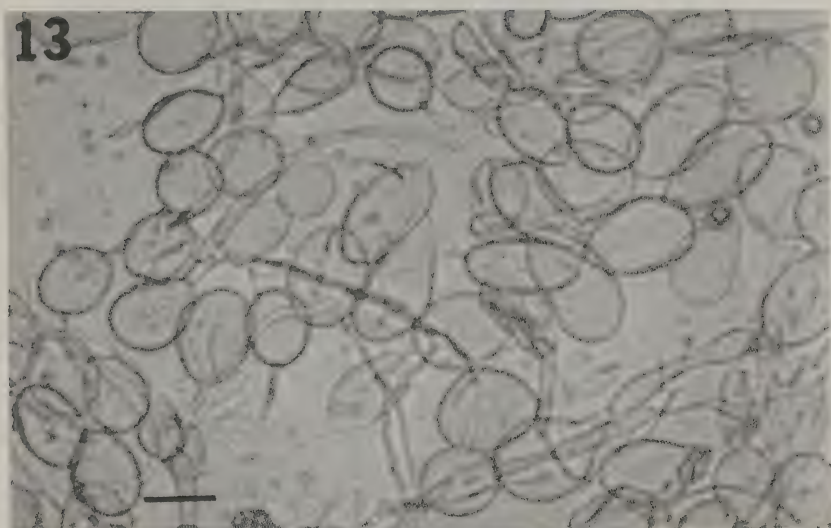
Material examined: Dominican Republic: Cordillera Central, La Vega Prov., above Manabao, Jose Cruz's farm, $19^\circ 4' 46''$ lat., $70^\circ 48' 11''$ long., 14 Jan 1997, H. Miller & D.J. Lodge, OKM 26806 (VTMH 3920; JBSD). Santiago Prov., 24 Nov. 1999, Parque Bermúdez, Anton Sape Bueno entrance, $19^\circ 12' 7.4''$ lat., $70^\circ 59' 0''$ long., 950 m elev., J.G. Torrez & T.J. Baroni, OKM 27695; La Celestina, Community Forest, 25 Nov. 1999, O.K. & H. Miller, OKM 27706 (HOLOTYPE)(CFMR-1411; JBSD); T.J. Baroni 35, TJB- 8998 (JBSD 94018; NY); D.J. Lodge, O.K. & H. Miller, OKM 27710 (CFMR-1413; JBSD).

Observations: All developmental stages have been studied and the distinctive duplex universal veil composed of a thin white outer veil with pyramidal warts together with a powdery cinnamon to rusty brown inner veil (Figs. 17 & 18), and the inamyloid spores are a unique combination of characteristics not seen in any other *Amanita*. In addition, each wart is centered in a shallow depression (Fig. 18) creating a scalloped pattern over the surface of the buttons. Remains of the powdery universal veil are often present on the surface of the lower part of the stipe (Fig. 17 on left), and form a thick layer on the lower side of the partial veil. The range of spore dimensions is very narrow ($7\text{--}9.5 \times 6\text{--}8 \mu\text{m}$; $E_m = 1.23$; $E = 1.0\text{--}1.5$). This species was first discovered on the Jose Cruz plantation as a single basidiome in 1997 (OKM 26806), and is named in his honor. The non amyloid spores place it in the subgenus *Amanita*, where no

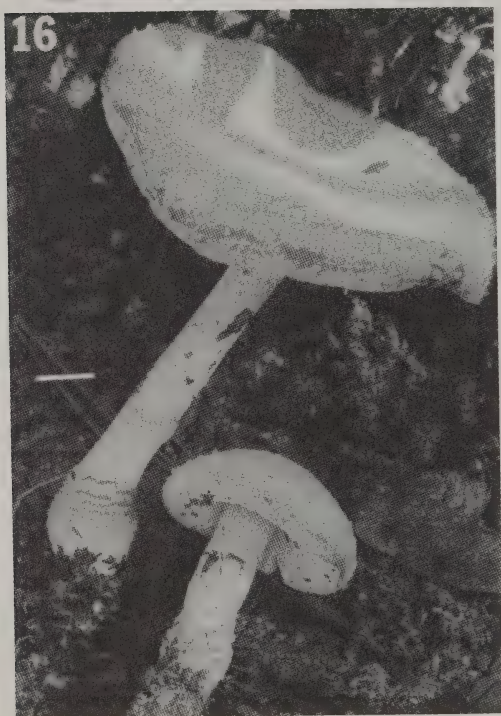
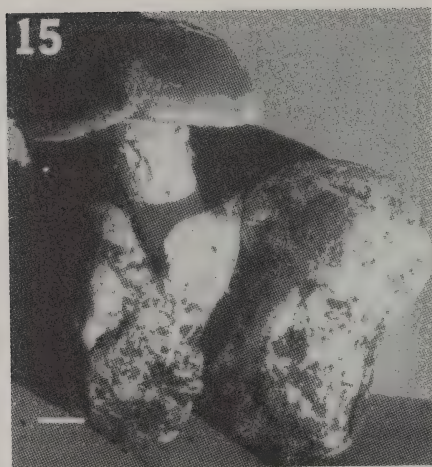
comparable taxon has been described. In addition, the stipe and general stature of our taxon is more robust than other somewhat similar species in subgenus *Amanita*. The cheilocystidia (Fig. 6) are located in a narrow band on the lamellar edge, and are directly attached to hyphae of the trama. The powdery inner universal veil remnants on the pileipellis are the spherical to inflated cells identical to the ones illustrated in Fig. 14. *Amanita rufoferrunginea* Hongo also has a powdery reddish brown universal veil, but it differs from *A. cruzii* in having smaller spores ($5.5\text{--}9 \times 5\text{--}7.5$ vs. $7\text{--}9.5 \times 6\text{--}8 \mu\text{m}$), absence of white pyramidal warts, and the universal veil is composed of larger filamentous hyphae and smaller ovoid to swollen cells ($11\text{--}18$ vs. $10\text{--}26 \mu\text{m}$ wide). Another somewhat similar taxon, *A. aureofloccosa* Bas, differs from *A. cruzii* in having orange squamules on the pileus, and strongly amyloid spores that are globose and $6.5\text{--}9.5 \mu\text{m}$ diameter (Pegler, 1977) rather than inamyloid, subglobose to broadly ellipsoid, and $7\text{--}9 \times 6\text{--}7.5 \mu\text{m}$. None of the species of *Amanita* described by Pegler (1983) in his flora of the Lesser Antilles nor in other literature we have examined matches this new taxon.



Figures 10-12. Fig. 10. *Amanita occidentalis*. Interwoven filamentous hyphae from universal veil. Figs. 11-12. *Amanita circinata*. Fig. 11. partial veil tissue with swollen cells and filamentous hyphae. Fig. 12. Universal veil largely composed of ovoid to swollen cells. Bar = 10 μ m



Figures 13-14. *Amanita cruzii*. Fig. 13. White pyramidal warts of the universal veil composed largely of ovoid to globose cells and filamentous hyphae. Bar = 10 μm .



Figures. 15-16. *Amanita occidentalis*. Button on right with thick universal veil. Bar = 1 cm. Fig. 16. *Amanita circinata*. Note the pyriform warts on the lower pileus. Bar = 1 cm.



Figures 17-18. *Amanita cruzii*. Fig. 17. Specimen on the left exhibits early maturity with much of the outer universal veil sloughed off leaving the powdery inner veil. Specimen on the right is nearly mature with remnants of the inner universal veil remaining but the superior partial veil still in place. Bar. = 1 cm. Fig. 18. A young specimen showing the scalloped surface and distinctive white pyramidal warts with the thin white film in between which makes up the outer universal veil and the powdery inner universal veil over the margin. Bar = 1 cm.

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Notes on discomycetes in Dongling Mountains (Beijing)

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ABSTRACT

Investigation of discomycete diversity in the area around Dongling Mountains over the past two years has resulted in the collection of more than 100 specimens. These belong to the following families: Helvellaceae, Sarcoscyphaceae, Pezizaceae, Otideaceae, Sclerotiniaceae, Orbiliaceae, Dermateaceae, Hyaloscyphaceae and Helotiaceae. Among them, *Hymenoscyphus adlasiopodium* and *Trichophaea donglingensis* are proposed as new species. Several collections are new records for China: *Crociereas fuscum*, *Hydnocystis japonica*, *Hymenoscyphus fructigenus*, *Mollisia* cf. *caesia*, *Octospora humosa*, *Orbilina delicatula*, *Orbilina luteorubella*, *Peziza* cf. *pseudoviolacea*, *Psilopezia deligata* and *Pulvinula militina*.

Keywords: *Hymenoscyphus adlasiopodium*, *Trichophaea donglingensis*, new species.

INTRODUCTION

The Dongling Mountains are located west of Beijing on the boarder of Beijing City District and Hebei Province. The region ranges from 800-1500m in elevation and can reach an elevation of nearly 2100m. The climate is temperate and precipitation is abundant between May to September. The vegetation of the mountains is mainly composed of secondary mixed forests of *Populus*, *Salix*, *Corylus*, *Quercus* and *Juglans* and plantations of *Pinus*, which were introduced in the past twenty years. Work centered at the ecological research station of The Institute of Botany, Chinese Academy of Sciences which provides good access to field sites and good working conditions. Several expeditions to the region were organized recently by the Systematic Mycology and Lichenology Laboratory, Academy of Sciences (SMLL) in order to study the diversity of various groups of fungi. These were funded by the Director's Fund from Institute of Microbiology and a major program (39893360) of National Natural Science Foundation of China. More than 100 specimens of discomycetes were collected by the writers and their associates, and all materials were deposited in the Herbarium of Microbiology Academia Sinica (HMAS). Based on these collections 50 taxa are reported in this paper, including *Hymenoscyphus adlasiopodium* and *Trichophaea donglingensis*, which are new to

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sciences. In the list that follows the name in boldface type indicate taxa not previously reported from China (Zhuang 1998).

ASCOCORNYE CYLICHNIUM (Tul.) Korf

ASCOCORNYE SARCOIDES (Jacq.) J. W. Groves & Wilson

CHLORENCOELIA TORTA (Schwein.) J. R. Dixon

CHLOROCIBORIA AERUGINASCENS (Nyl.) Kanouse ex Ram., Korf & Batra

CIBORIA BATSCHIANA (Zopf) N. F. Buchw.

***CROCICREAS FUSCUM* (W. Phillips & Harkn.) S. E. Carpenter**

GEOPORA PERPROLATA B. C. Zhang

HELVELLA ALBELLIA Quéf.

HELVELLA ATRA Holmsk.: Fr.

HELVELLA CHINENSIS (Velen.) Nannf. & L. Holm

HELVELLA CRISPA Scop.: Fr.

HELVELLA ELASTICA Bull.: Fr.

HELVELLA LACUNOSA Afzel.: Fr.

HELVELLA PEZIZOIDES Afzel.: Fr.

HUMARIA HEMISPHERICA (Fr.) Fuckel

***HYDNOCYSTIS JAPONICA* (Tak. Kobay.) Trappe**

Notes: Kobayasi (1963) erected a monotypic genus *Protogenea* in the Tuberales based on *P. japonica* Tak. Kobay. He distinguished *Protogenea* from *Hydnocystis* because ascomata in the genus *Protogenea* "are epigeous, have an apical opening, and are not tomentose." Trappe (1975) treated *Protogenea* as a synonym of *Hydnocystis*, and suggested that the information Kobayasi gleaned from a single collection was insufficient and that some characters had been missed by Kobayasi. The senior writer examined isotypes of *P. japonica* and *H. piligera* Tul. & Tul. (type species of *Hydnocystis*) kept in Farlow Herbarium, and also examined several collections from China (HMAS 75844 from Beijing, Dongling Mountains, HMAS 74673 and FH-WZ2209 from western Sichuan). The specimens examined share several key characters of ascocarps, asci and ascospores, but all the Chinese materials fit the description Kobayasi gave for *P. japonica* well. The surface of the ascomata is nearly smooth. Another important character observed by the senior writer in the Chinese material is that the paraphyses extend far beyond the asci, and are free rather than fused at apex as is the case in *H. piligera* (Trappe 1979). We do not regard this as justification to recognize *Protogenea* as a distinct genus. However, we do suggest *H. japonica* represents a species distinct from *H. piligera*.

***HYMENOSCYPHUS ADLASIOPIDIUM* Zheng Wang sp. nov. (Fig. 1)**

Ab Hymenoscypho lasiopodii apotheciis 3-4mm diam, ascis 145-155 x 9-11µm differt. In caulibus radici busque gramineis ignotis cariosis evolutis.

Apothecia discoid, stipitate to subsessile, 3-4mm diam; hymenium orange-yellow; receptacle paler than hymenium; stipes up to 4mm long. Ectal excipulum of textura prismatica to textura angularis, ca 50-85µm thick, Medullary excipulum of textura intricata, 170-500µm thick. Asci 8-spored, J+, 145-155 x 9-11µm. Ascospores fusoid, irregularly uniseriate, possibly indistinctly septate, multiguttulate, 20-30 x 3.5-5.0µm. Paraphyses subcylindrical, 2.5-4.0µm wide.



Fig 1. Ascus and ascospores of *Hymenoscyphus adlasiopodium* (HMAS 75878), scale= 10 μ m.

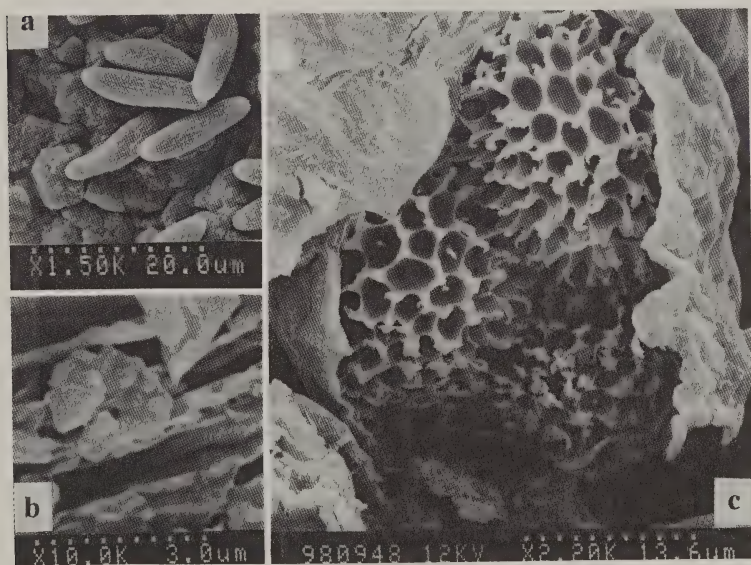


Fig 2. Ascospores a) ascospores of *Karschia stygia*, b) ascospores of *Orbilia delicatula*, c) ascospores in a broken ascus of *Tuber taiyuanense* (HMAS 75888).

Holotype: on rotten roots of *Carex humilis* Leysser, Dongling Mountains, Beijing, Zheng Wang (0242) 18 VIII 1998, HMAS 75878.

Other specimens examined: on rotten roots of *Carex humilis* Leysser, Dongling Mountains, Beijing, Zheng Wang (0261), 18 VIII 1998, HMAS 75880; on root (or stem base) of a grass, Baihua Mountains, Beijing, HMAS 71819, 71820, 71821.

Zhuang & Wang (1998) described this fungus in detail under the name *H. lasiopodium* (Pat.) Dennis. The species and *H. lasiopodium* were confused because the ascospores are similarly shaped. They noted differences in morphology and suggested it might be influenced by environmental conditions. *H. lasiopodium* is distributed in the tropics, found on wood and rarely on herbaceous stems in very wet areas, and it has smaller apothecia (1-1.5mm) with smaller asci (110-115 x 6-8µm). The senior author has collected *H. adlasiopodium* many times in the area around Beijing (temperate region), and the morphological characters, host, and distribution are always stable. Considering the difference between this species and *H. lasiopodium*, two species should be recognized.

HYMENOSCYPHUS CAUDATUS (P. Karst.) Dennis

***HYMENOSCYPHUS FRUCTIGENUS* (Bull.: Fr.) Gray**

The materials fit well the description of Lizon (1992).

HYMENOSCYPHUS REPANDUS (W. Phillips) Dennis

The first record of this species in China is from Taiwan (Wu, Wang & Chow 1996).

JAFNEA FUSICARPA (W. R. Gerard) Korf

KARSCHIA STYGIA (Berk. & M. A. Curt.) Massee (Fig. 2 a)

Although the placement of this genus is uncertain, the author follows Dennis (1968) and treats it as a discomycetes. Unlike the description by Teng (1963), this collection has longitudinally striated ascospores.

LACHNUM CF. *CARICIS* (Desm.) Höhn.

LACHNUM NUDIPIES (Fuckel) Nannf.

LEOTIA LUBRICA Fr.

MICROSTOMA FLOCCOSUM (Schwein.) Raitv.

***MOLLISIA* CF. *CAESIA* (Fuckel) Sacc.**

Based on description of *Mollisia caesia* by Seaver (1951), the Chinese material seems close to it on account of its large ascospores (11-17 x 2-2.5µm), but the hymenium of the Chinese material is grayish instead of bluish-gray and some ascospores seem to be uniseptate at maturity.

MOLLISIA CINEREA (Batsch) P. Karst.

***OCTOSPORA* CF. *HUMOSA* (Fr.) Dennis**

The Chinese material agrees in spore size, but the excipulum differs from *O. humosa*, as described by Rifai (1968) and Caillet & Moyne (1987) in its pseudoparenchymatous construction.

***ORBILIA DELICATULA* (P. Karst.) P. Karst.** (Fig. 2 b)

Scanning electron microscopy has proven informative for identification of the species. The distinct ornamentation of the ascospores can best be seen in this way (Pfister 1997).

***ORBILIA LUTEORUBELLA* (Nyl.) P. Karst.**

The morphology of the Chinese materials fit the description by Seaver (1942) but differs in the color of the hymenium, which is bright yellow rather than pale yellowish-red.

PEZIZA MICHELII (Boud.) Dennis

***PEZIZA* CF. *PSEUDOVIOLEACEA* Donadini**

The almost smooth ascospores and purplish hymenium of the material fit the concept of the species, but compared with the description of Hohmeyer (1986), the Chinese material has smaller ascospore ($11.5\text{--}13 \times 5.5\text{--}6.5\mu\text{m}$ vs. $13\text{--}16 \times 7\text{--}9\mu\text{m}$).

***PEZIZA* SP.**

Apothecium solitary, irregularly discoid, 38mm diam; disc shallowly concave, dark brown; receptacle surface smooth, beige; hymenium $220\text{--}230\mu\text{m}$ thick. Asci subcylindrical, tapering towards the base, 8-spored, with faint bluing at the apex in Melzer's reagent, ca $230 \times 15\mu\text{m}$. Ascospores hyaline, ellipsoid, $13\text{--}15 \times 8\text{--}9\mu\text{m}$, mostly uniguttulate, surface usually covered by minute warts visible in optical section; warts usually irregular in shape, less than $0.5\mu\text{m}$ wide and up to $0.2\mu\text{m}$ high. Paraphyses cylindrical, septate, unbranched, $4\text{--}7\mu\text{m}$ diam, slightly bent at the apex encrusted blackish-brown drops.

Specimen examined: On rotten wood with mosses, Zheng Wang (2246), 16 IX 1998, HMAS 74659.

The specimen is unique in the small ascospores with fine irregular warts, beige nearly white receptacle, and very slight reaction in Melzer's reagent. Such a combination of characters is unknown to the writer in the wood-inhabiting members of *Peziza*.

PEZIZA SUBUMBRINA (Boud.) M. M. Moser

***PSILOPEZIA DELIGATA* (Peck) Seaver**

Compared with the description of Seaver (1942) and Pfister (1973), the Chinese material has smaller ascospores ($23\text{--}27 \times 12.5\text{--}15\mu\text{m}$ vs. $28\text{--}35 \times 15\text{--}20\mu\text{m}$). Zhuang (1997) published *P. dabaensis* and emphasized that the excipulum of her species is quite different from that of the known species in the genus. The material from the Dongling Mountains fits the characteristics of *P. dabaensis* in many respects, but differs from the former in having an excipulum like that seen in *P. deligata* and in *P. nummularialis* (Pfister, 1973; Pfister & Candoussau 1981). *P. nummularialis* has a range of the ascospores's size of $26\text{--}29 \times 12\text{--}15\mu\text{m}$, which is closer to that of Chinese material than *P. deligata* is, but *P. nummularialis* is found only in France. Considering the wide distribution of the species *P. deligata*, and the similarities of the fungal flora between East Asia and North American, *P. deligata* is accepted here for the Chinese material rather than *P. nummularialis*.

PULVINULA LAETERUBRA (Rehm) Pfister

***PULVINULA MILITINA* (Berk.) Rifai**

The stalk-like (unforked) bases of the asci are the defining character of this species. Compared with the description by Rifai (1968), the asci of Chinese material are somewhat tapering below instead of abruptly narrowing at the base.

SARCOSCYPHA VASSILJEVAE Raitv.

SCUTELLINIA COLENSOI Massee ex Le Gal

SCUTELLINIA CRINITA (Bull.: Fr.) Lambotte

SCUTELLINIA KERGUELENSIS (Berk.) Kuntze

SCUTELLINIA SUBHIRTELLA Svrcek

SMARDAEA MICROSPORA J. Z. Cao, B. Liu & M. Z. Fan

SMARDAEA PROTEA W. Y. Zhuang & Korf

SOWERBYELLA FAGICOLA J. Moravec

TARZETTA CATINUS (Holmsk.: Fr.) Korf & J. K. Rogers

TRICHOPHAEA BULLATA Kanouse

***TRICHOPHAEA DONGLINGENSIS* Zheng Wang sp. nov. (Fig. 3)**

Ab speciebus allis Trichophaeae pilis subviolaceo-roseis differt.

Apothecium discoid, solitary, sessile, 1-2.5mm diam, purplish-pink; receptacle surfaces brown and hairy. Hairs distributed over surface of receptacle, 4 or more in a fascicle, brown, thick-walled, septate, 40-150 x 5-10µm. Ectal excipulum of *textura angularis*, ca 130-150µm thick, cells 12-40 x 10-20µm, arranged perpendicular to the outer surface, sometimes stacked to form small pustules, the outermost layer of brown and thick-walled cells. Medullary excipulum of *textura intricata*, ca 150-300µm thick. Asci subcylindrical, narrower towards the base, 8-spored, apex not blued in Melzer's reagent, 262-275 x 15-18µm. Ascospores uniseriate, hyaline, ellipsoid, surface slightly pustulate to nearly smooth, uniguttulate to biguttulate, 22-26.5 x 12-14µm. Paraphyses filiform, septate, swollen at the apex, to 4-6µm.

Holotype: on soil, Dongling Mountains Beijing, 1998 IX 16, Zheng Wang (2261), HMAS 74672.

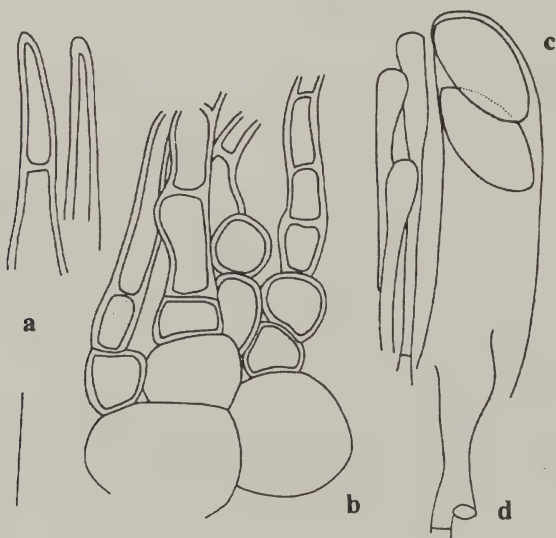


Fig 3. *Trichophaea donglingensis* (HMAS 74672) **a)** apices of hairs, **b)** bases of hairs and cells of ectal excipulum, **c)** apex of ascus and several paraphyses, **d)** base of ascus. scale=20µm.

The senior author and his colleagues' attention was drawn to these apothecia because of their purplish-pink color. Superficially they are similar to the species of the genus *Scutellinia*. Purplish-pink apothecia are not previously known in the members of *Trichophaea*. The biguttulate ascospores and brown, thick-walled hairs arising from the ectal excipulum place this species in *Trichophaea* but the color distinguishes it from all other taxa in that genus. *Trichophaea pallidibrunnea* W.-y. Zhuang & Korf, described as new mainly because of its light-yellowish hymenium and pale brown hairs (Zhuang & Korf 1989), may be close to this species.

TRICHOPHAEA WOOLHOPEIA (Cooke & W. Phillips) Boud.

TUBER TAIYUANENSE B. Liu (Fig. 2 c)

Neotype designated here: In soil about 5cm deep under pines, Hua-an Wen, Xiao-qing Zhang & Zheng Wang (0294), 20 VIII 1998, HMAS 75888.

The holotype of this species was destroyed in a fire. The collection, especially the characters of its ascospores, fits the original description (Liu 1985) very well, so it is designated neotype of *Tuber taiyuanense* Liu.

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GALIELLA CELEBICA FROM INDIA

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Abstract: *Galiella celebica* is reported for the first time from India. The very faint ascospore markings have been verified with SEM photographs. General characters and dimensions of apothecia and ascospores have been compared with earlier records.

Key Words: Discomycetes, Pezizales, Sarcoscyphineae.

Korf (1957) published a new genus *Galiella* Nannf. & Korf with *G. rufa* (Schwein.) Nannf. & Korf as the type species along with three other species for which new combinations were provided in *Galiella*.

Creation of the new genus was necessary because Le Gal (1953) had used the generic name *Sarcosoma* Casp. in a sense that excluded its holotype (*S. globosum*). Thus the generic name *Sarcosoma* became unavailable for the fungi treated by her under that generic name.

Though criticized by Le Gal (1958) and Boedijn (1959), the name *Galiella* has been accepted by most authors. Cao, Fan and Liu (1992) accepted the cyanophilic ornamentation of ascospores as one of the most important diagnostic generic features in Sarcoscyphineae as suggested by Korf (1973), and recorded 4 species of *Galiella* from China.

The present paper deals with a curious looking fungus collected over 20 years ago in the subtropical forest of Naugarh near Varanasi. The fungus has been identified as *G. celebica* and as an excellent modern

description of this species is available (Le Gal 1953) only a brief discussion along with figures of the Indian specimen are provided.

Galiella celebica (Henn.) Nannf. in Korf (Mycologia 49: 108, 1957). Apothecia up to 5 cm. diam. thick and gelatinous (compares well with Hennings' size of 3–6 cm.), although Le Gal had slightly smaller, 2–3 cm. diam, apothecia. The thick medullary excipulum of textura intricata tissue is embedded in gel. Ascospore size is also very variable. Hennings recorded spores $23\text{--}27 \times 11\text{--}13 \mu\text{m}$, while Le Gal had larger ($26.5\text{--}34.5 \times 10\text{--}17.5 \mu\text{m}$) spores. The Indian collection has the spores $16.5\text{--}34.5 \times 10\text{--}17.5 \mu\text{m}$ with very faint markings (which this author failed to observe for a long time and Prof. Korf points out [pers. comm.] that preservation in FAA, perhaps, was responsible for the poor reactivity of the markings to cotton blue dye). The apothecia are clothed with short hairs.

As mentioned above the nature of spore surface was in doubt for a long time until the spores were examined under the Scanning Electron Microscope. The SEM photographs revealed the presence of minute tubercles on the spore surface. Only after seeing the delicate but very clear spore markings under SEM was the author able to confirm that the minute markings can also be discerned under the light microscope.

Specimen examined: on rotting roots of an unidentified plant, Naugarh Forest Chandauli, (Varanasi), leg. V. P. Tewari and K. B. Khare, August 9, 1978, BHUPP 1659, CUP-IN 658.

Although there is no published record of a *Galiella* species from India, Kaushal (1982) included a *Galiella* taxon. sp., collected from the neighbouring Himalayan Kingdom of Bhutan, in his thesis. Efforts to locate this specimen (PAN 18409) in the Panjab University Herbarium proved futile. However, the description provided mentions the apothecia up to 1.7 cm. diam and gelatinous, ascospores $26.5\text{--}35 \times 11.4\text{--}12.2 \mu\text{m}$ minutely warted, elliptic fusoid, and hymenial hairs up to 3 μm wide and septate. The accompanying figures in the thesis (pl. IX, figs.1-3), however, neither indicate the presence of gel in the tissue nor the hymenial hairs. Hymenial hairs are also not known in other species of the genus. Therefore unless the specimen can be located and re-examined the taxonomic status of this report from Bhutan will remain doubtful.

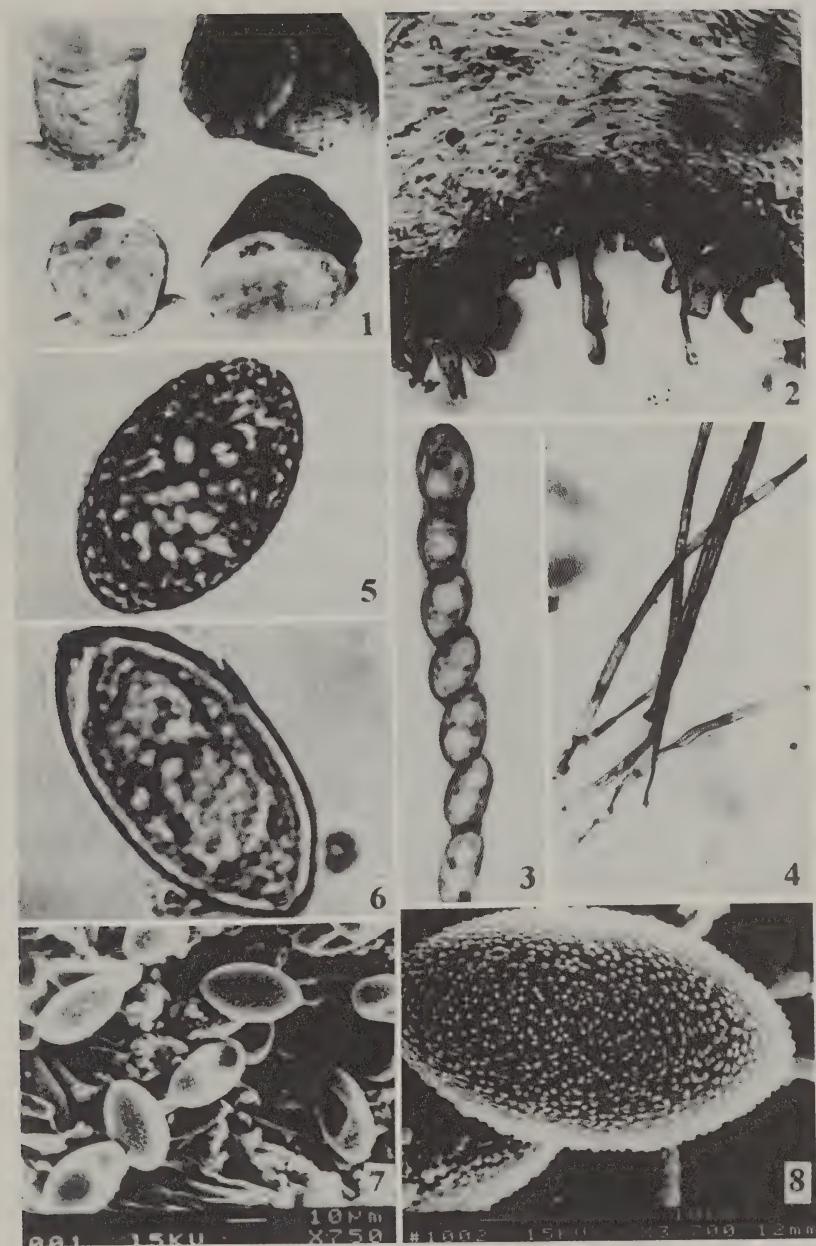


Plate I. *Galiella celebica*. 1. Apothecia, x0.5; 2. Ectal excipulum, x400; 3. Ascus, x600; 4. Septate hairs, x250; 5. Mature ascospores, x2100; 6-8. SEM photographs of ascospores, x750 and x3700 respectively.

The present paper, therefore, constitutes the first record of a *Galiella* species from India.

The author is thankful to Dr. R. P. Korf, Professor Emeritus, Department of Plant Pathology, Cornell University, U.S.A., for the identification of the specimen and many improvements in the manuscript. Thanks are also due to Prof. J. P. Tewari, Department of Agricultural Food and Nutritional Science, University of Alberta, Canada, for help in SEM photographs.

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THE LICHEN GENUS *TOPELIOPSIS* IN AUSTRALIA AND
REMARKS ON AUSTRALIAN THELOTREMATACEAE

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Key words: Lichenized fungi, *Myriotrema*, *Leptotrema*, *Reimnitzia*, *Thelotrema*.

Abstract: The lichen genus *Topeliopsis* in Australia is monographed. Four species are kept in this genus, *T. acutispora* sp. nova, *T. corticola* sp. nova, *T. muscigena* comb. nova and *T. vezdae* sp. nova. The recently described *T. muscicola*, the type species of the genus, is reduced into synonymy with *T. muscigena*. The description for the genus is emended. - The monotypic genus *Reimnitzia* gen. nov. is described for *Thelotrema santense* and its position within the Thelotremataceae is discussed. *Thelotrema heterosporum* is synonymized with *Reimnitzia santensis* and reported from Australia-NT for the first time; *Thelotrema nostalgicum* and *T. vernicosum* are new additions to the Australian lichen flora, the latter also for the Mascarene Islands. *Thelotrema vernicosum* is the correct name for *T. piluliferum*. - The genus *Leptotrema* is synonymized with *Myriotrema*.

Introduction

The lichen genus *Topeliopsis* Kantvilas & Vězda has been described recently (KANTVILAS & VĚZDA 2000) to accommodate species of the family Thelotremataceae with hyaline, thin-walled, non-halonate, highly muriform ascospores, turning reddish or purple in iodine, 1-2 (-4) per ascus. The excellent habitus drawings by Vězda in the paper cited above called back to mind some of our collections made in 1988 in cool temperate rainforests of New South Wales and Queensland (Australia). But the subsequent study of these specimens revealed some major differences (e.g. spores halonate, transversely septate or weakly muriform, thick-walled, turning deep blue in iodine, 8 per ascus). Therefore we restudied the type species of the genus, *Topeliopsis muscicola* Kantvilas & Vězda (Isotype, hb. Vězda), and found it without any doubt to be congeneric with our specimens. Consequently, the diagnosis presented by KANTVILAS & VĚZDA (2000), must be corrected as far as coloration of the ascospores in iodine and the thicken-

ing of their walls are concerned, and be extended regarding the septation of the ascospores and their number per ascus.

Material and methods

This study is based mainly on the collections of the author and relevant type material housed in the herbaria mentioned. Measurements of anatomical details were performed in water-mounted slides. The chemistry was analysed by TLC or HPTLC, using the standardized method by CULBERSON & KRISTINSSON (1970), CULBERSON (1972) and CULBERSON & JOHNSON (1982).

The genus *Topeliopsis* Kantvilas & Vězda emend.¹

Thallus crustose, sometimes evanescent; photobiont *Trentepohlia*. *Apothecia* sessile or subimmersed, subglobose to barrel-shaped, perithecioid or sometimes becoming gyalectoid, closed at first, later opening by a terminal pore. *Excipulum* in section cupular, hyaline or slightly yellowish, externally usually with a thin thalline layer, internally with hyaline periphyses. *Disc* markedly and persistently urceolate. *Paraphyses* straight, simple. *Asci* non-amyloid, cylindrical, thin-walled, with a markedly thickened apex when young, 1-8-spored. *Ascospores* hyaline, ellipsoid or oblong, thick-walled when mature, halonate, with transverse septa, submuriform or highly muriform, turning blue or purplish blue in iodine. *Conidiomata* unknown. Lacking lichen substances detectable by TLC or HPTLC.

Fig. 1 shows an ascospore of *T. muscicola* and it is clearly seen that the spore belongs to a type with thickened walls. Only fully mature ascospores show this character distinctly enough, young or even semimature ascospores are thin-walled, even in *T. corticola* (fig. 2 and 3). Similar conditions are observed in the lichen genus *Letrouitia*, where in transversely septate ascospores the thickened septa are easily observed as well as in submuriform ones, but very difficult or not to be seen in muriform spores with many cells (HAFELLNER 1981).

The species

Topeliopsis acutispora Kalb sp. nova

Thallus tenuis, 20-65 μm crassus, typice muscos emortuos incrustans, cinereo-albidus. *Apothecia* adnata vel in thallo semi-immersa, 0.4-0.7 mm lata, primum clausa, subglobosa vel doliiformia, primum perithecioidea poro terminali, demum gyalectoidea, excipulo extus fissurato, exfoliato, albo-pruinoso, in sectione 80-140 μm crasso, hyalino vel pallide fusco, in Iodo partialiter caerulescenti, intus sub ostiolum periphysibus copiosis, 15-25 μm longis et 2-3 μm crassis instructo, disco demum aperto, carneo. Hypothecium hyalinum, vel

¹ This description and also the layout of the species descriptions have been taken from KANTVILAS & VÉZDA (2000) with alterations where necessary.

dilute testaceum, 25-30 μm crassum. Hymenium hyalinum, 140-170 μm crassum. Paraphyses simplices, rectae, 1-1.5 μm crassae, apicibus non incrassatis. Asci (tetra- vel) octospori; ascospores hyalinae, oblongo fusiformes, halonatae, 90-130 $\times$ 9-12 μm , halo 1-2 μm crassus, cum 25-35 septis transversalibus, in Iodo fortiter caerulescentes.

Type: AUSTRALIA. **Queensland:** Cunninghams Gap National Park, ca. 40 km NW of Warwick, cool temperate rainforest, 750 m, 28°00' S, 152°24', 12. VIII. 1988, leg.: K. & A. Kalb (21901, CANB-holotype).

Thallus usually muscicolous, seldom switching from bryophytes to mouldering bark, crustose, thin (20-65 μm thick) to almost absent, whitish grey to greenish grey, effuse, not delimited, continuous. Apothecia adnate or partly innate in the thallus, 0.4-0.7 mm broad, at first subglobose to barrel-shaped with the excipulum completely closed, then opening by a ragged, central, ostiole-like pore, finally gyalectoid. Excipulum pale pink, becoming radially fissured, scurfy, exfoliating, whitish pruinose; disc completely enclosed at first, later $\pm$ exposed, persistently urceolate, flesh coloured. Excipulum at first with algal cells at the outer edge, 80-140 μm thick, hyaline, cupular and extending beneath the hymenium, internally I+ partly bluish; paraphyses abundant at the inner edge, at the upper part 25 μm long, becoming shorter (15 μm) downwards. Hypothecium hyaline or very light brown, 25-30 μm thick. Hymenium hyaline, 140-170 μm thick, I-; paraphyses simple, straight to somewhat flexuose, separating easily, 1-1.5 μm thick, ends not thickened, sometimes acute. Asci cylindrical, 140-160 $\times$ 30-45 μm , easily rupturing and releasing the mature ascospores. Ascospores (4-) 8 per ascus, hyaline, halonate, 90-130 $\times$ 9-12 μm with both ends acute, halo 1-2 μm thick, with 25-35 thick, I+ deep blue septa and lentiform lumina.

Chemistry: no substances detectable with TLC and HPTLC.

Distribution and ecology: *T. acutispora* is overgrowing mosses or smooth mouldering bark with a high water-holding capacity in cool temperate rainforests in New South Wales and southern Queensland.

Additional specimens examined:

AUSTRALIA. **New South Wales:** Styx River State Forest, ca. 68 km E of Armidale, cool temperate rainforest along a rivulet, 800 m, 30°34' S, 152°13' E, 11. VIII. 1988, leg.: K. Kalb & J. Williams (hb. Kalb 20121), growing together with *T. vezdae*; **Queensland:** Lamington National Park; Beechmont Range, Binna Burra, cool temperate rainforest with *Nothofagus moorei*, 900 m, 28°13' S, 153°11' E, 17. VIII. 1988, leg. K. & A. Kalb (hb. Kalb 22003).

Remarks: Actually, all four known *Topeliopsis* species are externally $\pm$ identical and are not discernible without microscopic investigations. But also the slight differences in the dimensions of internal tissues and structures are not sufficient to distinguish the species. As furthermore the ecology within the genus is very homogenous too (different species sometimes growing side by side), all these facts are not re-

peated in the English descriptions. The only way to separate the species easily is by regarding the shape, dimensions and septation of the ascospores and their number per ascus.

***Topeliopsis corticola* Kalb sp. nova**

Thallus tenuis, 25-75 μm crassus, typice corticola, sed etiam muscos emortuos incrustans, cinereo-viridis. Apothecia adnata vel in thallo semi-immersa, 0,4-0,7 mm lata, primum clausa, subglobosa vel doliiformia, primum perithecioidea poro terminali, demum gyalectoidea, excipulo extus fissurato, exfoliato, crasse albo-pruinoso, in sectione 50-100 μm crasso, hyalino vel pallide fusco, in Iodo partialiter caerulescenti, intus sub ostiolum periphysibus copiosis, 20-25 μm longis et 2-3 μm crassis instructo, disco demum aperto, carneo. Hypothecium hyalinum, 15-30 μm crassum. Hymenium hyalinum, 200 μm crassum. Paraphyses simplices, rectae, 1-1,5 μm crassae, apicibus non incrassatis. Asci (tetra- vel) octospori; ascosporae hyalinae, ellipsoideae, rectae vel leviter arcuatae, halonatae, 50-60 $\times$ 13-18 μm , cum 12-14 septis transversalibus, et 0-4 septis longitudinalibus, in Iodo fortiter caerulescentes, halo 1-2 μm crassus (fig. 2).

Type: AUSTRALIA. New South Wales: Blue Mountains National Park; Mount Wilson, Chimney Cottage, in a moist cool temperate rain-forest, 1000 m, 33°30' S, 150°23' E, leg. K. & A. Kalb (20462, CANB-holotype).

Additional specimen examined:

AUSTRALIA. New South Wales: New England National Park; Radar Station Site, 1.5 km NW of Point Look Out, in a *Nothofagus*-forest along a rivulet, 1500 m, 30°29' S, 152°25' E, 10. VIII. 1988, leg. K. Kalb & J. Williams (21227).

This species is separated from *T. muscigena* by 8 ascospores per ascus, which are much smaller (50-60 $\times$ 13-18 μm in *T. corticola* versus 100-200 $\times$ 24-52 μm in *T. muscigena*) and with fewer septa (12-14/0-4 versus 30-50/6-15).

Chemistry: no substances detectable with TLC and HPTLC.

***Topeliopsis muscigena* (Stizenb.) Kalb comb. nova**

$\equiv$ *Thelotrema muscigena* Stizenberger, Jahresber. St. Gall. nat.wiss. Ges. 1888/89: 247 (1890). – **Type:** South Africa, Cape Province, supra muscos ad arbores in Monte Tabulari, VIII. 1887, leg.: Mac Owan (ZT-holotype!, PRE-338, PRE-340, isotypes!).

Syn.: *Topeliopsis muscicola* Kantv. & Vězda, Lichenologist 32: 348. – **Type:** Tasmania, Quamby Bluff, 41°39'S, 146°42'E, on *Nothofagus cunninghamii* in rainforest, 800 m, 10. VIII. 1985, leg.: G. Kantvilas 202/85 (HO-holotype, Vězda-isotype!).

A comparison of the types of *T. muscicola* and *T. muscigena* show that they are identical in every respect. The spore size in *T. muscigena* is

100-165 $\times$ 24-39 μm and fits well within the range given for *T. muscicola* (106-200 $\times$ 27-52 μm).

This is the only species in the genus with monosporous asci.

The peculiar distribution pattern (Kapensis – Australis) is also known e.g. from the tree fern *Todea barbara* (L.) T. Moore (SCHMITHÜSEN (1961) and the lichen *Collema leucocarpum* Hook. fil. & Tayl. (DEGELIUS 1974).

Topeliopsis vezdae Kalb spec. nova

Thallus tenuis, typice muscos emortuos incrustans, sed raro etiam cortices vetustas incolens, cinereo-albidus. Apothecia adnata vel in thallo semi-immersa, 0,5-0,8 mm lata, primum clausa, subglobosa vel doliiformia, primum perithecioidea poro terminali, demum gyalectoidea, excipulo extus fissurato, exfoliato, crasse albo-pruinoso, in sectione 50-100 μm crasso, hyalino vel pallide fusco, in lodo partialiter caerulescenti, intus sub ostiolum periphysibus copiosis, 20-30 μm longis et 2-3 μm crassis instructo, disco demum aperto, carneo. Hypothecium hyalinum, 15-30 μm crassum. Hymenium hyalinum, 200 μm crassum. Paraphyses simplices, rectae, 1-1,5 μm crassae, apicibus non incrassatis. asci tetra- vel octospori; ascosporae hyalinae, oblongo fusiformes, halonatae, 55-100 $\times$ 10-16 μm , halo 1-2 μm crassus, cum 14-24 septis transversalis, in lodo fortiter caerulescentes.

Type: AUSTRALIA. **Queensland:** Styx River State Forest, ca. 68 km E of Armidale, cool temperate rainforest along a rivulet, 800 m, 30°34' S, 152°13' E, 11. VIII. 1988, leg. K. Kalb & J. Williams (19199, CANB-holotype).

Additional specimens examined:

AUSTRALIA. **Queensland:** Lamington National Park; Beechmont Range, Binna Burra, cool temperate rainforest with *Nothofagus moorei*, 900 m, 28°13' S, 153°11' E, 17. VIII. 1988, leg. K. & A. Kalb (21942). **New South Wales:** Blue Mountains National Park; Mount Wilson, Chimney Cottage, in a moist cool temperate rainforest, 1000 m, 33°30' S, 150°23' E, 31. VII. 1988, leg. K. & A. Kalb (20481); New England National Park; Radar Station Site, 1.5 km NW of Point Look Out, in a *Nothofagus*-forest along a rivulet, 1500 m, 30°29' S, 152°25' E, 10. VIII. 1988, leg. K. Kalb & J. Williams (hb. Kalb 21220); Styx River State Forest, ca. 68 km E of Armidale, cool temperate rainforest along a rivulet, 800 m, 30°34' S, 152°13' E, 11. VIII. 1988, leg. K. Kalb & J. Williams (hb. Kalb 19200, mixed with *T. acutispora*).

This species differs from *T. acutispora* by shorter but broader ascospores with less septa and obtuse ends.

Chemistry: no substances detectable with TLC and HPTLC.

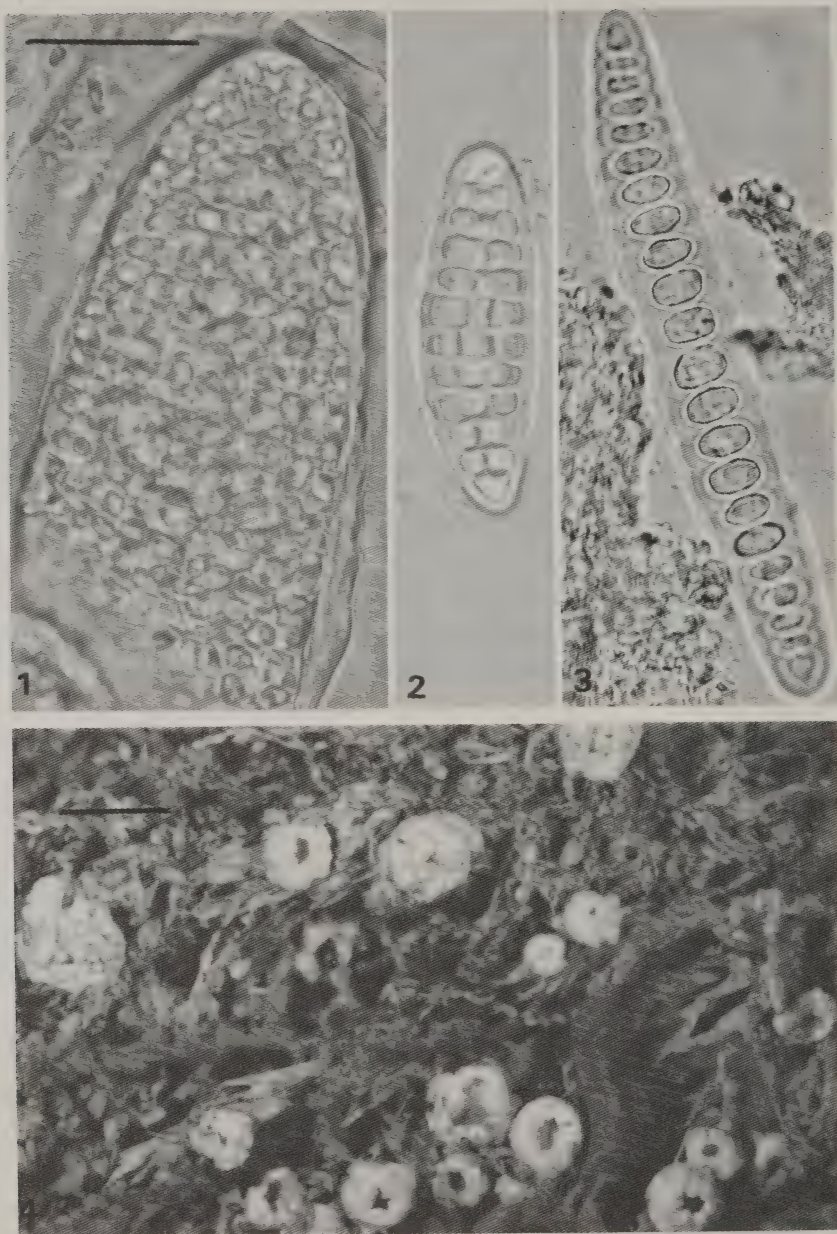


Fig. 1: *Topeliopsis muscicola*, ascospore (isotype); Fig. 2: *T. corticola*, ascospore (holotype); Fig. 3: *T. vezdae*, ascospore (holotype); bar = 30 μ m. Fig. 4: *T. vezdae*, habitus; bar = 1 mm.

Remarks: As already indicated by KANTVILAS & VĚZDA (2000), the genus as defined by them is heterogenous. After a careful study of all species, assigned to *Topeliopsis* by these authors, we can confirm this statement and would like to leave only the type species, *T. muscicola* (= *T. muscigena*), in the genus. The other species differ in spore type and excipulum structure and probably belong to another undescribed genus.

Key to the known species of *Topeliopsis*

- | | | |
|----|--|--------------------------|
| 1 | Ascospores muriform | 2 |
| 1* | Ascospores transversely septate | 3 |
| 2 | Ascospores single in the ascus, 100-200 × 24-52 µm | |
| | <i>T. muscigena</i> (Stiz.) Kalb | |
| 2* | Ascospores eight in the ascus, 50-60 × 13-18 µm | <i>T. corticola</i> Kalb |
| 3 | Ascospores 90-130 × 8-12 µm, 25-35-septate, ends acute | |
| | <i>T. acutispora</i> Kalb | |
| 3* | Ascospores 55-100 × 10-16 µm, 14-24-septate, ends obtuse | |
| | <i>T. vezdae</i> Kalb | |

Remarks on Australian Thelotremataceae

Reimnitzia Kalb gen. nov.

Genus novum ad familiam Thelotremataceae pertinet. Imprimis epithecio concreto (= paraphysibus in partes superioris dense ramosis et intricatis) definatur. Ab *Thelotrema* sensu str. excipulo libero et paraphysibus instructo deficiente differt, ab *Leptotrema* sensu str. (= *Myriotrema*) disco late aperto et margine apotheciorum recurvo differt et ab *Ocellularia* sensu str. excipulo non carbonisato et columella deficiente differt.

Typus generis: *Reimnitzia santensis* (Tuck.) Kalb comb. nov.

Bas.: *Thelotrema santense* Tuck., Proc. Amer. Acad. Arts and Sci. 5: 406 (1862) – Type: U.S.A. South Carolina, Santee Canal. (Woodbine Spring, 1859), on *Ulmus americana*, leg.: Ravenel (BM, lectotype!, selected by SALISBURY 1971, FH-Tuck, isolectotype!).

Syn.: *Leptotrema santense* (Tuck.) Zahlbr., Cat. lich. univers. 2: 635 (1923). – *Thelotrema heterosporum* C. Knight in Bailey, Synops. Queensl. Flora, Suppl. 1: 72 (1886) – Type: Australia; Queensland, on mosses, C. Knight (fide SALISBURY 1971). – *Leptotrema heterosporum* (C. Knight) Zahlbr., Cat. lich. univers. 2: 635 (1923). – *Leptotrema mastoideum* Müll. Arg., Flora 70: 400 (1887), nom. superfl. pro *T. heterosporum* C. Knight.

The new genus is dedicated to our Australian friends Michael and Christine Reimnitz who have helped us so much during all our excursions in Australia, and especially in 1988 when they saved our lichen collections by carefully drying the water saturated specimens.

The type species is unique within the Thelotremataceae and so far the only species that can be assigned to the new genus *Reimnitzia*. The main feature separating it from other Thelotremataceae is the distinct epithecium, which is formed by densely interwoven, branched upper parts of the paraphyses. - *Reimnitzia santensis* was placed in *Lep-*

totrema by ZAHLBRUCKNER (1923), but the type species of the genus is *Leptotrema zollingeri* Mont. & v.d. Bosch, and a careful examination of this species shows it to be conspecific with *Myriotrema wightii* (Taylor) Hale. Therefore, *Leptotrema* Mont. & v.d. Bosch (1855) becomes a later synonym of *Myriotrema* Fée (1824). - From *Myriotrema* sens. str. with immersed apothecia opening by a tiny pore, *Reimnitzia* is separated especially by chroodiscoid apothecia with recurved thalline walls, but the thick walled brown ascospores are much different from the thin walled and colourless ones in *Chroodiscus* (Müll. Arg.) Müll. Arg. - From *Thelotrema* Ach., which is typified by *T. lepadinum* (Ach.) Ach., *Reimnitzia* differs by the lack of a free excipulum and the lack of distinct periphyses. - *Ocellularia* G. Meyer, with *Thelotrema obturatum* Ach = *Ocellularia cavata* (Ach.) Müll. Arg. as type species, is separated by a carbonized excipulum. - Molecular genetic studies may show a closer relationship of *Reimnitzia* with *Diploschistes* Norman, but the latter genus lacks vegetative propagules (isidia) and has a carbonized excipulum similar to that in *Ocellularia*. Furthermore, the only facultatively corticolous *Diploschistes* species, *D. muscorum* (Scop.) R. Sant., produces several lichen substances (lecanoric and diploschistesic acids), whereas there are no lichen substances present in *Reimnitzia*. - Pycnidia cylindrical, immersed in the thallus or more often in the tips of the isidia, visible only as blackish dots. Conodiospores of type II (VOBIS 1980), conidia formed acrogenously, bacilliform to bifusiform, $4-8 \times 1.5-2 \mu\text{m}$.

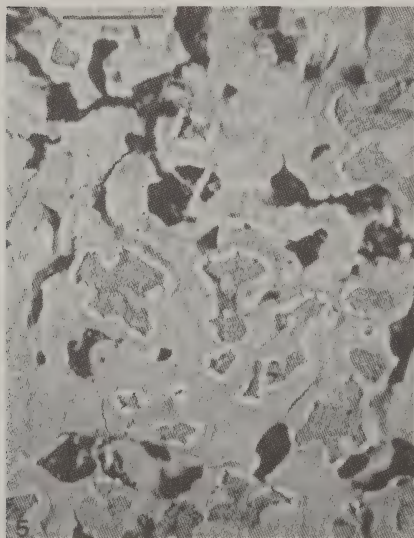


Fig. 5: *Reimnitzia santensis*, thallus with very sparse isidia and many apothecia; Fig. 6: *Reimnitzia santensis*, thallus with a few apothecia and many isidia; bar = 2 mm

Reimnitzia santensis is distributed pantropically with scattered localities outside the tropics. We have seen collections from North America (South Carolina, Florida), Central and South America (Guatemala, Venezuela, Brazil, Paraguay), Africa (Mozambique) and Australia (Queensland, Northern Territory). Our collection from Northern Territory: Kakadu National Park, „Gungarre Monsoon Forest“, near South Aligator, 75 m, 12°41'S, 132°29'E, 17. VIII. 1995, leg. K. & A. Kalb (Kalb 30585, dupl. in CANB) is the second report for this species in Australia and a new state report.

Additions to the Australian lichen flora

Thelotrema nostalgicum G. Salisbury

Lichenologist **5**: 266 (1972). *Type*: Sri Lanka. Pidurutalagala, on bark, 1879, leg.: Almquist s.n. (H-Nyl, holotype; S, isotype).

SALISBURY (1972) described his new species from Sri Lanka and HALE (1981) reported on the unusual chemistry, fumarprotocetraric (major) and protocetraric (minor – trace) acids. The cooccurrence of these two substances and the large (120-215 × 20-33 µm) transversely septate, colourless ascospores with 24-34 septa make the identification easy.

This species has not yet been reported from outside Sri Lanka. The two collections cited below represent a large range extension and are new reports for the Australian lichen flora.

AUSTRALIA. Queensland: Lamington National Park, near O'Reillys guesthouse, in a subtropical rainforest 1000 m, 28°15'S, 152°05'E, 16. VIII. 1988, leg.: K. & A. Kalb (Kalb 21538); dto. McPherson Range, Duck Creek road, in a subtropical rainforest, 900 m, 24°14'S, 153°07'E, 18. VIII. 1992, leg.: K. & A. Kalb (Kalb 25792, dupl. CANB).

Thelotrema vernicosum A. Zahlbr.

Ann. mycol. **10**: 370 (1912). *Type*: Hawaii; Oahu, Koolau Mountains, leg.: Rock 101 (W, lectotype; FH, isoelectotype, selected by HALE 1981).

Syn.: *Thelotrema pachystomum* Nyl. ssp. *piluliferum* Tuck., Proc. Amer. Acad. Arts Sci. **7**: 227 (1866). *Type*: Hawaii; Oahu, Waialua Mountains, leg.: Mann s.n. (FH-Tuck, lectotype; G, W, isoelectotypes; selected by HALE 1981). – *Thelotrema gibbosum* Magn., Ark. Bot. **31A(1)**: 53 (1944). *Type*: Hawaii; Maui, Haelaau, 1 Aug. 1938, leg.: Selling 5836 (UPS, lectotype; S, isoelectotype, selected by HALE 1981).

This species has been usually cited as *Thelotrema piluliferum* Tuck. (e. g. ZAHLBRUCKNER 1923, HALE 1981), but TUCKERMAN (1866) clearly described it as a subspecies of *Thelotrema pachystomum* Nyl. "It appears therefore likely, the general agreement between these plants being undeniable that they express only conditions of the same species" (TUCKERMAN 1966: 228). Although *Thelotrema pachystomum* and *T. pachystomum* subsp. *piluliferum* share the same chemistry, psoromic acid, they differ considerably in spore septation (three-septate versus muriform) and carbonization of the excipulum (carbonized versus non-carbonized). Therefore the two lichens have to be

treated as two distinct species and the oldest names on this level have to be used. TUCKERMAN (1866) reported this species from Hawaii, and HALE (1981) published further collections from Sri Lanka and Sabah. Its generic position is not yet clear, and the differences in the ascocarp structures compared to *T. lepadinum* are summarized by HALE (1981). Also the chemistry, psoromic acid, is not common in *Thelotrema* sensu str. The collections cited below represent range extensions and are new reports for the lichen flora of Australia and the Mascarene Islands.

AUSTRALIA. New South Wales: Styx River State forest E of Armidale; Beech Look Out, in a cool temperate rainforest, 1350 m, 30°29'S, 152°23'E, 10. VIII. 1988, leg. K. Kalb & J. Williams (Kalb 21401, dupl. CANB). – **MASCARENE ISLANDS. Réunion:** Cirque de Cilaos, trail from Thermales to Roche Mervilleussmall e, in remnants of primary rain forest, 1400 m, 21°07'S, 55°28'30"E, 20. VIII. 1991, leg. K. & A. Kalb (Kalb 25491).

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We thank the curators of the herbaria mentioned, especially Dr. A. Vězda, who has sent much material of *Topeliopsis* and related species on loan. Dipl. Biol. A. Frisch has critically reviewed this paper and Dr. B. Coppins corrected the English.

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DISCOMYCETES OF THE SARCOSCYPHACEAE IN TAIWAN

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ABSTRACT: Five species of the Sarcoscyphaceae, *Cookeina insititia*, *C. sinensis*, *Microstoma floccosum*, *Phillipsia domingensis*, and *Sarcoscypha humberiana*, collected from Taiwan are described and illustrated. Ascospores were observed under scanning electron microscopy. Except for *P. domingensis*, the ascospores of the other four species have generally been considered as smooth, whereas the SEM studies show that they have various delicate ornamentations. *Cookeina sinensis* and *Phillipsia domingensis* are recorded for the first time from Taiwan.

KEYWORDS: *Cookeina*, *Microstoma*, *Phillipsia*, *Sarcoscypha*, Pezizales.

Cookeina insititia (Berk. and M.A. Curtis) Kuntze, Rev. Gen. pl. 2: 849, 1891.
Fig. 3A.

Apothecia gregarious, cupulate, disc white to pale pinkish yellow, 0.5-1.0 cm wide, receptacle white to pale brown, stalk 0.1-2 cm high, hairs growing out from outer layer, white, like petals surrounding margins. Ectal-excipulum two layered, outer layer of a *textura globulosa*, cells 10-20 μm wide, layer 20-55 μm thick, inner layer gelatinous, with intricate hyphae 2-5 μm wide, medullary excipulum of a *textura intricata*, layer 50-88 μm thick. Asci 8-spored, suboperculate, clavate, 410-475 x 15-20 μm . Ascospores fusoid, smooth under light microscopy, verrucose under SEM, hyaline, with many small oil drops, 40-55 x 10-11 μm . Paraphyses branched, connected like a net, hyphae 3-5 μm wide.

Colonies on CMA medium spreading slowly. Mycelium velvety, pinkish white, reaching 4.8-5.6 cm diam. in 14 days at room temperature; conidia not seen.

Specimens examined: Taiwan. Chiayi: Alishan-Fengshan; alt. 1800 m, on rotten wood, L.Y. Liao, Sep. 13, 1993 (TNM F1167). Kaohsiung: Maolin, on rotten wood, W.N. Chow; 911024, Jan. 24, 1991 (TNM F1114); Liukuei, Shanping, alt. 750 m, on rotten

wood, *S.Z. Chen*, 9312206, 93122208, Dec. 22, 1993 (TNM F1452, F1454). Miaoli: Tahu, Shuiliutung, on rotten wood, *S.Z. Chen*, *WAN* 079, Sep. 25, 1994 (TNM F2494); Cholan, on rotten wood, *C.C. Wen*, *WAN* 621, Nov. 22, 1998 (TNM F8926); Shihshuikeng, on rotten wood, *C.C. Wen*, *WAN* 631, Nov. 30, 1998 (TNM F8936). Pingtung: Nanjenshan, alt. 250 m, on dead wood, *C.C. Wen*, *WAN* 349, Nov. 9, 1996 (TNM F5296); *C.C. Wen*, *WAN* 607, Aug. 7, 1998 (TNM F8915). Taitung: Orchid Island; alt. 50 m, on dead twigs, *S.Z. Chen*, *WAN* 415; *C.C. Wen*, *WAN* 416, Apr. 23, 1997 (TNM F5693, F5694); Orchid Island, alt. 100 m, on rotten wood, *J.Y. Tseng* and *S.H. Wu* 9704-146, Apr. 29, 1997 (TNM F7979).

This species was previously reported by Lion and Chen (1977) under the genus *Boedijnopeziza*. It is very common within broadleaf forests below 1000 m in elevation in southern Taiwan. The morphology of the apothecia is variable, the length of the stalk may be from 0.1 to 2 cm, and the color of the receptacle varies from white to pale brown.

Cookeina sinensis Z. Wang, Mycotaxon 62: 293, 1997.

Figs. 1, 3C, 3D.

Apothecia scattered, discoid, stipitate, disc deeply concave, pinkish orange, 1.5-4.5 cm wide, stalk 1.5-4 cm long; receptacle pale pinkish, covered with long, white to brownish hairs composed of bundles of hyphae arising from the medullary tissue, 3-5 mm long. Ectal-excipulum of a *textura globulosa* to *angularis*, cells 10-40 μ m in diam., layer 150-175 μ m thick, medullary excipulum of a *textura porrecta*, hyphae septate, 7.5-10 μ m wide, hymenium layer pinkish, 500-525 μ m thick, easily separated from excipular layer. Asci 8-spored, cylindrical, 325-387 x 17.5-20 μ m, thick walled, 2-3 μ m thick, base contracted into a narrow short stalk. Ascospores subfusoid, pointed at both ends, 27-37.5 x 13-15 μ m, with fine and irregular wrinkles barely visible under oil immersion lens, containing two large oil drops and many small ones, pale yellow when mature. Paraphyses threadlike, branched, and connected with each other, 2.5-4 μ m wide.

Colonies on CMA medium spreading slowly. Mycelium velvety, white, reaching 6.9-8 cm diam. in 14 days at room temperatures; conidia not seen.

Specimens examined: China. Yunnan, Xishuangbanna, on twig, *Y. Li* 372, Jun. 8, 1986 (holotype, HMAS 70088); Menlen, on rotten wood, *M. Zang* 10398, Aug. 15, 1985 (paratype HMAS 70310). Taiwan. Miaoli : Tahu, Shuiliutung, on dead wood, *S.Z. Chen*, *WAN* 074, Sep. 4, 1994 (TNM F2490); Shitan, on rotten wood, *W.N. Chou*, *WAN* 785, July 7, 2000. Nantou: Hsitou, on rotten wood, Sep. 9 1992, *C.M. Chen*, (TNM F0781). Taitung: Orchid Island, Hungtoushan, alt. 350 m, on dead twigs, *S.Z. Chen* and

C.C. Wen, WAN 426, Apr. 24, 1997 (TNM F570); Tienchi, on rotten wood, *S.Z. Chen* 930, Oct. 24, 1999. Taoyuan: Changhsing, alt. 350 m, on dead twigs, *C.N. Chen*, WAN 697, July 14, 1999 (TNM F9857).

This species is similar to *C. tricholoma* in gross morphology, but the latter has longitudinal ridges on the ascospores. The ascospores of the Chinese and Taiwanese collections were examined under SEM and the results show that both have the same pattern of ornamentation (Fig. 3C, D). All Taiwanese collections were found within broadleaf forests below 1000 m in elevation. Five species of *Cookeina* have been reported from China (Wang 1997), but only two species have been collected in Taiwan.

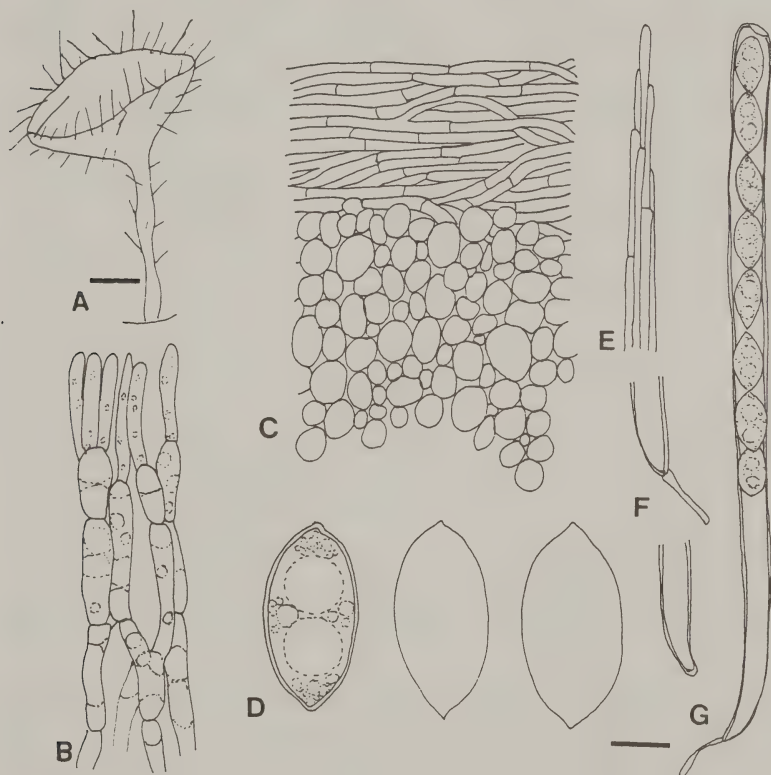


Fig. 1. *Cookeina sinensis* (TNM F0781) A. an apothecium. B. paraphysis tips. C. a part of the excipulum. D. ascospores. E. hair tips. F. bases of asci. G. an ascus. Bars = 1 cm for A; 10 μ m for B and D; 25 μ m for C and E; and 24 μ m for F and G.

Microstoma floccosum (Schwein.) Raitv., Eesti NSV Tead. Akad. Toim., Biol. Ser. 14: 529, 1965.

Fig. 3B.

Apothecia scattered to gregarious, stipitate, cupulate, disc orange red, 0.4-0.9 x 0.3-0.5 cm, receptacle paler, covered with white hairs, 125-1000 μm long, stalk 0.5-1.5 cm long, base with dark brown hyphal mat. Ectal-excipulum of a *textura angularis*, cells 7.5-15 μm diam., layer 25-50 μm thick, medullary excipulum of *textura porrecta*, hyphae regularly arranged, 5-7.5 μm wide, layer 225-250 μm thick, subhymenium 75-125 μm thick, hymenium 250-270 μm thick. Asci 8-spored, suboperculate, clavate, 205-311 x 12-18 μm . Ascospores ellipsoid, smooth under light microscopy, verrucose under SEM, 23-29 x 10-13 μm , with many small oil drops at both ends. Paraphyses branched, connected as a net, with many orange granules, 2-3 μm wide.

Specimens examined: Taiwan. Miaoli: Kuanwu-Hsuehchieh, alt. 1900 m, on dead twigs, C.A. Chiu, CCA 17, Sep. 2, 1995 (TNM F3684). Nantou: Hoshe, alt. 780 m, on dead twigs, S.Z. Chen, WAN 024, May 2, 1994 (TNM F1912); Y.Z. Wang, WAN 278, Apr. 10, 1996 (TNM 4565); W.N. Chou, WAN 284, Apr. 25, 1996 (TNM 4571); Tungpu, on branches of broadleaf trees, S.Z. Chen, WAN 389, Feb. 18, 1997 (TNM F5671).

This species is easily recognized by the orange, stipitate, hairy apothecia. The brown subiculum on the substrate is a unique characteristic within this family.

Phillipsia domingensis (Berk.) Berk., J. Linn. Soc. London Bot. 18: 388, 1881.

Figs. 4, 6E.

Apothecia scattered, discoid, 0.8-2.5 cm diam., with a short stalk, disc dark red, brown when dry, receptacle yellowish white. Excipulum with *textura intricata*, hyphae 2.5-3 μm , light yellow, 20-50 μm thick, medullary excipulum with hyphae loosely arranged; hymenium 750-875 μm thick. Asci 8-spored, suboperculate, cylindrical, 350-375 x 15-17 μm . Ascospores ellipsoid, hyaline, 23-27.5 x 12.5-15 μm , containing 1-2 oil drops, surface with 3-6 straight lines. Paraphyses simple, filled with reddish pigment, tips 4-5 μm .

Colonies spreading rapidly on PDA medium. Mycelium initially white then turning brownish, reaching 9.0 cm diam. on CMA within 14 days at room temperature, hyphae 2-3 μm wide. Anamorph: *Moellardiomyces domingensis*, conidia numerous, hyaline, ellipsoid, 8-12 x 6-7 μm .

Specimens examined: Taiwan. Nantou: Tungpu, on rotten wood, S.H. Wu 9285, Aug. 22, 1992 (TNM F0674); Wushe, Pihu, alt. 870 m, on dead wood, W.N. Chou, WAN 308, July 4, 1996 (TNM F5133). Pingtung: Nanjenshan, alt. 250 m, on dead twigs, W.N. Chou, WAN 331, Sep. 6, 1996 (TNM F5156); on rotten wood, C.C. Wen, WAN 502, Oct.

8, 1997 (TNM F7686); Chufengshan, alt. 300 m, on rotten wood, C.C. Wen, WAN 496, Sep. 18, 1997 (TNM F7681). Taitung: Orchid Island, Chungai Bridge, on rotten wood, J.Y. Tseng and S.H. Wu 9704-84, Apr. 30, 1997 (TNM F7415); Hsiaotienchi, alt. 100 m, on rotten wood, S.Z. Chen 977, Oct. 25, 1999 (TNM F10183).

This species is usually collected in forests below 1000 m in elevation in middle and southern Taiwan. Paden (1984) reported *Molliardiomyces domingensis* as the anamorph of this species. It is new to Taiwan.

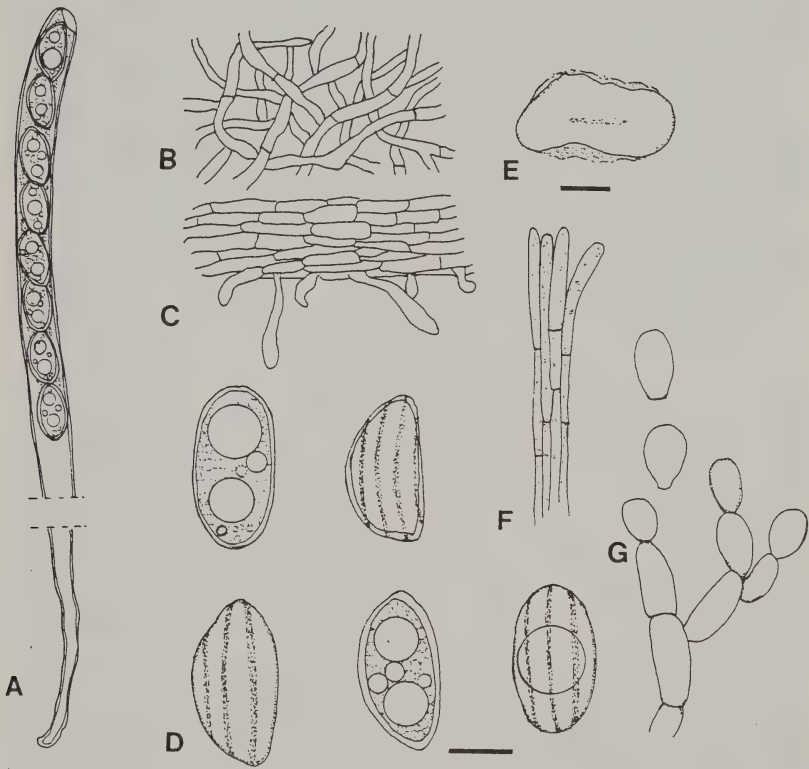


Fig. 2. *Phillipsia domingensis* (TNM F7681) A. an ascus. B. a part of the medullary excipulum. C. a part of the ectal-excipulum. D. ascospores. E. an apothecium. F. paraphyses tips. G. conidiophore and conidia. Bars = 25 μ m for A, B, and C; 10 μ m for D, F, G; and 1 cm for E.

Sarcoscypha humberiana F.A. Harr., Harvard Papers Bot. 10: 56, 1997.

Fig. 3F.

Apothecia scattered, discoid, with a short stalk, disc brightly red, 1-3 cm diam., stalk 0.3-1.8 cm high, receptacle white, tomentose. Ectal-excipulum of *textura intricata* to *prismatica*, layer 50-75 μm thick, hyphae 2-3 μm wide, medullary excipulum of *textura intricata*, hyphae 3-5 μm wide, layer 800-1000 μm thick, subhymenium with compact hyphae, containing red pigment, layer 200-250 μm thick, hymenium layer 250-300 μm thick. Asci 8-spored, cylindrical, 287-416 x 9-12 μm . Ascospores ellipsoid, 19-32 x 8.5-12 μm , smooth under light microscopy, with irregular ridges under SEM, hyaline with 2 large oil drop when fresh, then degenerating into one central guttule, some spores truncate and concave at both ends. Paraphyses filled with red granules, tips 2-4 μm wide.

Colonies on CMA medium spreading very slowly. Mycelium pinkish white, margin smooth, reaching 2.8-2.9 cm diam. in 14 days at 20 °C, conidia not seen.

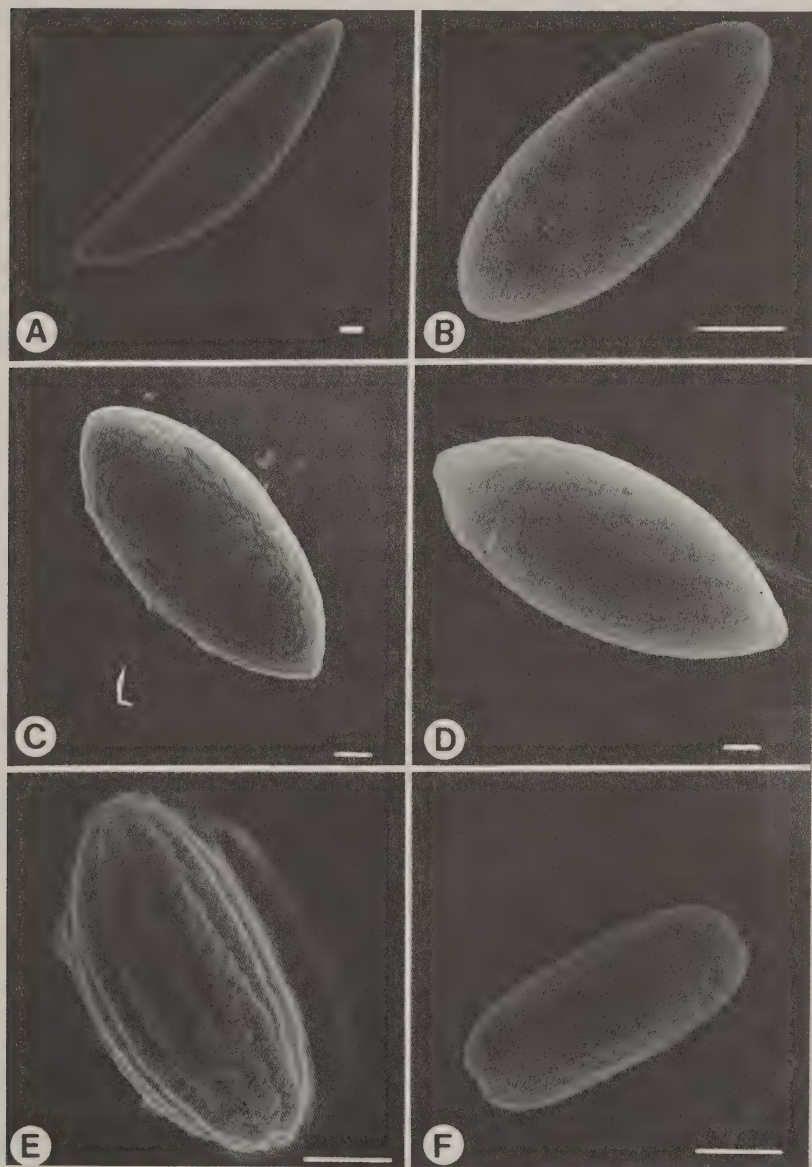
Specimens examined: Taiwan. Miaoli: Kuanwu-Hsuehchieh, alt. 1900 m, on dead twigs, C.A. Chiu; CCA 23, Sep. 2, 1995 (TNM F3688). Nantou: Meifeng, alt. 2150 m, on dead branches, C. P. Hsiao, WAN 010, Mar. 25, 1994 (paratype, TNM F2108); W.N. Chou, WAN 012, Apr. 7, 1994 (TNM F 2109); C.C. Wen, WAN 372, Dec. 19, 1996 (TNM F5395); Y. Z. Wang, WAN 559, WAN 560, Mar. 10, 1998 (TNM F8292, F8293); S.Z. Chen, WAN 642, Dec. 3, 1998 (TNM F9952); Tatacha, alt. 3000 m, on dead branches, J. M. Chen, Apr. 29, 1993, May 19, 1993 (TNM F754, TNM F993); Tungpu, on dead branches, W. N. Chou, WAN 189, Aug. 10, 1995 (TNM F3460); Wushe, alt. 870 m, on dead branches, W.N. Chou, WAN 309, July 4, 1996 (TNM F 5134).

Harrington (1997) published this species based on a duplicate of WAN 010 (TNM F2108). It has been treated as *S. occidentalis* (Schwein.) Sacc. (Liou and Chen 1977) in Taiwan. This species differs from *S. occidentalis* mainly by the large and tomentose apothecia (Harrington 1990, 1997). Paden (1984) described *Molliardiomyces occidentalis* and *M. coccinea* as anamorphs of *S. occidentalis* and *S. coccinea* respectively, but I have not found conidia in culture of this species. Zhuang (2000) recently published a new speceis, *S. Shennongjiana* from China.

DISCUSSION

The ascospore ornamentation of *Microstoma floccosum* is very delicate and compact, and those of *Cookeina insititia*, *C. sinensis*, and *Sarcoscypha humberiana* are very shallow and irregular, hence all are difficult to detect under light microscopy. The finding of ascospore ornamentation by SEM within the Sarcoscyphaceae is not unusual. Moravec (1997) reported that the ascospores of *Cookeina colensoi*, which have

commonly been considered as smooth, show very fine amoeboid-verrucose ornamentation under SEM. Zhuang (1993) reported that the ornamented ascospores of *Sarcoscypha occidentalis* forma *occidentalis* and *S. vassiljevae* are revealed by SEM. In future studies, more smooth-spored species of Sarcoscyphaceae will be proved to have ornamented ascospores by SEM.



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Fig. 3. SEM photographs of ascospores A. *Cookeina insititia* (TNM F5296). B. *Microstoma floccosum* (TNM F4565). C. *Cookeina sinensis* (holotype, HMAS 70088). D. *Cookeina sinensis* (TNM F0781). E. *Phillipsia domingensis* (TNM F10183). F. *Sarcoscypha humberiana* (TNM F8292). Bars = 5 μ m.

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SOME SPECIES OF *XYLARIA* (HYMENASCOMYCETES, XYLARIACEAE)

ASSOCIATED WITH OAKS IN MEXICO

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ABSTRACT

Fifteen taxa of the genus *Xylaria* growing on wood, fruit remains or leaves of *Quercus* spp., are reported from México. *Xylaria albisquamula*, *X. duranii*, *X. michoacana*, *X. quercinophila*, *X. subcoccophora*, and *X. tumulosa* are described as new. A dichotomous key for the considered taxa is provided.

KEY WORDS: Systematics, *Quercus*, cloud forest, anamorph, Mexico.

RESUMEN

Se reportan 15 taxa del género *Xylaria* que crecen en México sobre madera, restos de frutos u hojas de *Quercus* spp. Se describen las nuevas especies *Xylaria albisquamula*, *X. duranii*, *X. michoacana*, *X. quercinophila*, *X. subcoccophora* y *X. tumulosa*. Para los taxa considerados se provee una clave dicotómica.

INTRODUCTION

The Mexican flora is one of the most diverse on earth because practically every biome so far described is present in the country (San Martín, 1992). The main types of vegetation of México, recognized by Rzedowski (1978), are: the Evergreen Tropical Forest, the Deciduous Tropical Forest, the Spiny Forest, the Xerophytic Scrub, the Grassland, the *Quercus* Forest, the Conifer Forest, the Cloud Forest, and the Subaquatic and Aquatic Vegetation.

The abundance in México of species of *Pinus* and *Quercus* is remarkable. For example, according to Critchfield and Little (1966), there are 35 species of *Pinus* representing 39% of the total species for this genus in the world. Also between 100 and 125 species of *Quercus* are concentrated in Central and Southern México.

According to Zavala (1990), this large concentration of species is the greatest in the American Continent and perhaps in the entire world. It is not surprising, then, to find a great diversity of fungi associated with *Quercus* spp. in México.

The aim of this study was to contribute to the knowledge of the *Xylaria* species associated with oaks from various Mexican states. Collection, preservation, and identification methods of taxa follow San Martín and Rogers (1995). Cultures and anamorphic information were obtained as given in San Martín and Rogers (1993). Herbarium acronyms are largely based on Holmgren et al. (1990).

KEY TO *XYLARIA* SPECIES ASSOCIATED WITH *QUERCUS* OF MÉXICO

1. Stromata clavate to short clavate, with immersed perithecia and an acute sterile apex sometimes thread-like, the stipes short to long, tomentose to villose, 1-5 cm high x 1-3.5 mm broad, shiny-black, the white, brown or dark-brown outer layer peeling, with finely papillate to papillate-hemispherical ostioles. Ascospores brown to dark-brown, ellipsoid-inequilateral to navicular with narrowly rounded ends, sometimes bearing a hyaline appendage at one end, (14-) 15-17 (-18) x (4.5-) 5-5.5 μ m, the germ slits straight, oblique or sigmoid, slightly less than spore-length on concave side. On dead wood or fruit remains of *Quercus* aff. *germana* *Xylaria juniperus* var. *asperula*
1. Combination of features different 2
2. Stromata filiform with crowded, almost free perithecia, with acute sterile apex, and more or less long, villose stipes, 1-2 cm total length x 1-1.5 mm broad, black with concolorous outer layer, and slightly papillate to papillate-hemispherical ostioles. Ascospores light-brown to brown, translucent, 12-14.5 (-16) x 4-4.5 (-5) μ m, the germ slits straight or sigmoid, spore-length on concave side. On fruit remains and dried leaves of *Q. polymorpha* *Xylaria duranii* sp. nov.
2. Combination of features different. Stromata growing on dead wood 3
3. Ascospores with sigmoid or spiralling germ slits 4
3. Ascospores with straight germ slits 6
4. Stromata sessile, attached to substrate by a narrow connective, peltate to subglobose, 1-1.5 cm long x 7-8 mm wide x 4-9 mm high, surface white, finely cracked. Ascospores dark-brown to almost black, subglobose with abruptly pinched ends, (20.5-) 21.5-24.5 (-25) x (13.5-) 14-16 (-18.5) μ m *Xylaria michoacana* sp. nov.
4. Stromata stipitate. Combination of features differing from above 5
5. Fertile part conical to irregular, terete, with rounded fertile apex, on short to long stipe, 2-7 cm total length x 0.5-3 cm diam, surface white to yellowish, finely cracked. Ascospores dark-brown, ellipsoid-inequilateral with broadly or narrowly rounded ends, (19-) 20-23 (-25) x 8-9.5 (-10) μ m *Xylaria quercinophila* sp. nov.
5. Fertile part cylindrical, clavate to irregular, terete to compressed, with sterile acute apices, on short to long stipes, 4-9 cm total length x 2-5 mm diam, surface blackish with brown outer layer. Ascospores brown to dark-brown, ellipsoid-inequilateral to navicular with narrow to acute ends, (15.5-) 16-18 (-20) x 6-7 (-7.5) μ m *Xylaria* cf. *scruposa*.
6. Fertile part cylindrical, the uppermost portions often flattened, unbranched or branched, on short to long stipe, 7-10 cm long x 3-12 mm broad, surface reddish-brown to dull black, ornamented by reticulate cracks, the small papillae often surrounded by sunken discs. Ascospores brown, ellipsoid-inequilateral, the ends broadly or narrowly rounded, (9.5-) 10.5-13 (-14) x 4-5 (-5.5) μ m

-**Xylaria adscendens**
6. Sunken discs around papillae absent. Combination of features differing from above...7
7. Stromata cylindrical to irregular, unbranched or branched, terete to compressed, on ill- or well defined tomentose stipes, the acute apices sterile, 3.5-4 cm high x 2 mm broad; surface blackish, with white to brown outer peeling layer. Ostioles slightly papillate to conical. Ascospores brown to dark-brown, ellipsoid-inequilateral to navicular with narrow to narrowly rounded ends, (9-) 9.5-11 (-12) x 4.5-5 μ m.....
-**Xylaria sp. aff. hypoxylon**
7. Combination of features different..... 8
8. Fertile part with prominent perithecial contours 9
8. Fertile part with inconspicuous perithecial contours.....10
9. Stromata unbranched or branched consisting of a smooth, long rachis that extends upward as sterile apex and downward as stipe, 6-16 cm total length x 1.5-2 mm broad. Surface black. Ascospores brown, ellipsoid-inequilateral to navicular with narrowly rounded ends, (16.5-) 17-20 (-22) x (6-) 7-8 μ m.....
-**Xylaria tumulosa sp. nov.**
9. Stromata cylindrical, branched or unbranched, with long or short acute sterile apices, on short glabrous stipes, 1.5-3 cm total length x 2 mm broad, surface blackish with white peeling outer layer. Ostioles slightly papillate. Ascospores brown to dark-brown, ellipsoid-inequilateral to navicular with narrowly rounded ends, (9-) 10-11 (-11.5) x 4-5 μ m.....
-**Xylaria subcoccophora sp. nov.**
10. Stromata unbranched or branched, with acute sterile apices, on ill-defined stipes, up to 7 cm long x 2-4 mm diam, surface dark-brownish to blackish, tomentose. Ascospores yellowish, ellipsoid-inequilateral to fusoid or crescentic, 10-13 (-14) x (2.5-) 3-4 μ m, the germ slits obscure **Xylaria cf. magnoliae**
10. Ascospore germ slits evident. Combination of features differing from above 11
11. Stromata 5 mm or greater in diam. 12
11. Stromata less than 5 mm in diam. 13
12. Stromata clavate, unbranched, 1.5- 3.5 cm high x 7-9 mm broad, with inconspicuous, white to brownish scales, the smooth, black stipes discoid at the base, dark-brown. Ostioles obscure to slightly raised. Ascospores brown to dark-brown, navicular to somewhat crescentic, with narrow to more or less acute ends, 10-13 (-14) x 4-5 μ m**Xylaria albisquamula sp. nov.**
12. Stromata clavate, unbranched or branched at base, with rounded fertile apices, on short or long fluted stipes arising from a pannose base, 1.5-2.5 cm long x 4-6 mm diam. Surface copper-colored, becoming blackish and hollow. Ostioles finely papillate. Ascospores brown, ellipsoid-inequilateral with broadly or narrowly rounded ends, (8.5-) 9-11 (-12) x 4-5 μ m.....**Xylaria sp. cubensis complex**
13. Ascospores up to 12 μ m long.....14
13. Ascospores more than 12 μ m long.....15
14. Stromata cylindrical, branched or unbranched, with long or short, acute sterile apices, on short, glabrous stipes, 1.5-3 cm long x 2 mm broad, surface blackish with white peeling outer layer. Ostioles slightly papillate. Ascospores brown to dark-brown, ellipsoid-inequilateral to navicular, the ends narrowly rounded, (9-) 10-11 (-11.5) x 4-5 μ m.....**Xylaria subcoccophora sp. nov.**
14. Stromata cylindrical, unbranched or branched, cespitose, on ill-defined stipes, with acute sterile apex, 2-6 cm total length x 2-4 mm diam. Ostioles umbilicate to somewhat papillate. Ascospores brown to dark-brown, ellipsoid-inequilateral with broadly or narrowly rounded ends, (9-) 9.5-12 x 4-5.5 μ m**Xylaria longiana**

15. Stromata clavate to somewhat cylindrical, unbranched or branched, the apex rounded to blunt, sterile or fertile, terete to flattened, on ill- or well defined stipes, tomentose at the bases, the white outer peeling layer splitting in strips, 1-3 cm long x 1-2.5 mm broad. Ostioles finely to prominently conic-papillate. Ascospores brown to dark-brown, ellipsoid-inequilateral to navicular with narrow ends, (12-) 13-14.5 (-15) x 5-5.5 μ m **Xylaria** sp. aff. **longiana**
15. Stromata subglobose to short-cylindrical, branched or unbranched, the acute apices sterile, the villose stipes short or long, with brown to dark-brown outer layer, 0.7-6.5 cm long x 2-4 mm broad. Ostioles obscure to finely papillate conical. Ascospores brown, ellipsoid-inequilateral to navicular with narrow to narrowly rounded ends, (20-) 20.5-25 (-26) x (6.5-) 7-8 (-9) μ m **Xylaria** **apiculata**

DESCRIPTIONS

Xylaria adscendens (Fr.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 128. 1851.

The teleomorph is as described by Dennis (1961), Rogers (1984), and San Martín and Rogers (1989). The anamorph was as described by Callan and Rogers (1990).

SPECIMEN EXAMINED: Tamaulipas, Gómez Farías municipality, El Cielo Biosphere Reserve, San Martín 203, on cortex of living **Quercus** aff. **germana** Cham. & Schl. in cloud forest (ITCV, JDR).

NOTES: After study of the anamorph, collections reported as **Xylaria** sp. (SM 39 & 306) in San Martín and Rogers (1989), turned out to be small, tropical forms of **X. adscendens**.

The colony of **X. adscendens**, except for the yellow-greenish radial sectors and the shape and length of its conidia, was reminiscent of **X. multiplex** (Kunze) Fr. (see cultural descriptions of **X. multiplex** and **X. adscendens** in San Martín, 1992 and in Callan and Rogers, 1990, respectively, and notes on **Xylaria** cf. **scopiformis** [Mont. ex Joly] T. Schumacher, in San Martín, 1992).

Xylaria albisquamula San Martín, J. D. Rogers et Lavín sp. nov. Figs. 1, 2, 3, 4

Stromata non ramosa, clavata, 1.5-3.5 cm longitudine tota x 7-9 mm crassa, stipitibus nigellis, laevia, basi discoidea, extus primus lutea pruinosa oblecta, denique fusca, cum squamis inconspicuis albis vel brunneolis, intus alba vel lutea, cava. Textura dura sed fragilis. Superficies laevis cum subtili reticulationes. Perithecia 0.4-0.7 mm diametro. Ostiola inconspicuis vel parum conspicuis. Asci cylindrici, octospori, ordinate uniseriati vel parte biseriati, longissimo stipitate, 172-224 μ m longitudine tota x 6-7 (-7.5) μ m crassi, partibus sporiferis 62-79 μ m, annulo apicali in liquore Melzeri cyanescens, urniforme, 3 μ m alto x 2-3 μ m crasso. Ascosporae brunneae vel fuscae, naviculares vel aliquantum lunatae, extremis angustis vel acutatis, 10-13 (-14) x 4-5 μ m, rima germinativa recta abbreviata in latere concavo praeditae.

Status anamorphosis ignotus.

Stromata unbranched, clavate, 1.5-3.5 cm long x 7-9 mm broad, the stipes black, smooth, with a discoid base; externally at first covered with a yellow, pruinose outer layer, becoming dark-brown, with conspicuous, white to brownish scales, internally white to yellowish, becoming hollow. Texture hard but fragile. Surface smooth except for very fine reticulations. Perithecia 0.4-0.7 mm diam. Ostioles obscure to slightly raised. Asci cylindrical, eight-spored with uniseriate to partly biseriate spore arrangement, very long-stipitate, 172-224 μ m total length x 6-7 (-7.5) μ m broad, the

spore-bearing part 62-79 μm , with apical ring bluing in Melzer's iodine reagent, urn-shaped, 3 μm high x 2-3 μm broad. Ascospores brown to dark-brown, navicular to somewhat crescentic, with narrow to more or less acute ends, 10-13 (-14) x 4-5 μm , the straight germ slits less than spore-length on concave side.

Anamorphic state unknown.

The specific epithet alludes to the superficial, white, stromatal scales.

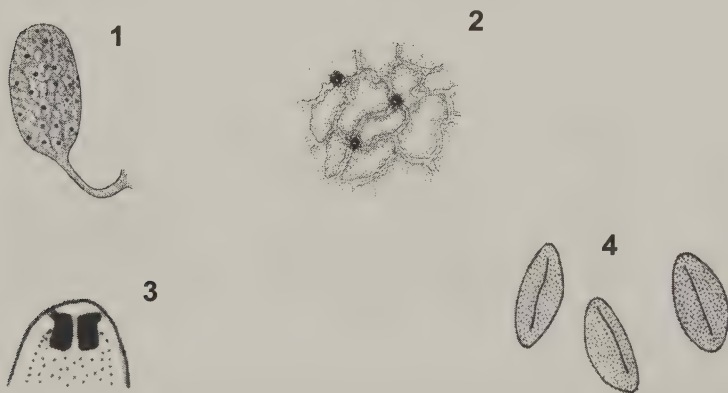
SPECIMENS EXAMINED: Chiapas, Jaltenango municipality, Santa Rita Colony-El Triunfo Hill hike trail, 7.VI.88, San Martín 657, on wood of a riparian element along river shore in a cloud forest (ITCV, JDR). Tamaulipas, Gómez Farías municipality, San José, 1470 m, 20.XI.1996, San Martín 5239T, on wood of *Quercus germana* Cham. & Schl. in cloud forest (ITCV: HOLOTYPE).

ADDITIONAL SPECIMENS EXAMINED: *Xylaria tuberosoides* Rehm, México, Oaxaca, 12.VII.1959, Heim s/n, on wood in tropical forest (MEXU-9720). Puerto Rico, Canovana municipality, Barrio Cubún, El Yunque, 11.VI.1998, San Martín 9008PR, on wood in median subdeciduous tropical forest (FSM).

NOTES: This member of *X. cubensis* complex appears restricted to cloud forests. In general it fits description of Cooke (1883) for *X. australis*, but the latter was collected at Endeavour River in Australia and has ascospores 15 μm long with narrow ends.

The Mexican fungus has the surface close to that of *Xylaria tuberosoides* Rehm, but the latter grows in tropical rain forests, lacks conspicuous white scales, its scarce entostroma is pinkish when mature, the apical ring is bigger i. e. 5-5 μm high x 3-4 μm broad, and its ascospores are considerably larger i. e. 25-28 x 5.5-6.5 (-7) μm (see Rehm, 1901 for description of *X. tuberosoides*).

Xylaria albisquamula also recalls *X. pallida* Berk. & Cooke from which it differs in having the outer layer split in white scales and larger ascospores (see San Martín and Rogers, 1989 for description of *X. pallida*).



Figs. 1-4. *Xylaria albisquamula*. 1: Stroma, 1 cm = 5 mm. 2: Detail of the stromatal surface showing punctate ostioles, 1 cm = 3.5 mm. 3: Ascus apical ring, 1mm = 0.5 μm . 4: Ascospores, 1 cm = 2.2 μm .

Xylaria apiculata Cooke, Grevillea 8: 66. 1879.

The teleomorph is as described by Rogers and Samuels (1986).

Colonies covering Petri dish in 5 wk, at first white with plumose margins, strongly zonate, felty to appressed, becoming dark-grey. Reverse uncolored to brownish. Stromata produced at the center or at the edges of the colony, acuminate to clavate, darkish with white-yellowish tips, branched to unbranched, with felty surface. Anamorphic structures not produced.

SPECIMENS EXAMINED: Chiapas, Jaltenango municipality, El Triunfo Hill, 8.VI.88, San Martín 696, on dicot wood in cloud forest (ITCV, JDR). Tamaulipas, Hidalgo municipality, ejido Conrado Castillo, VII.88, Lucrecia García 113A (CULTURED) & 116, on *Quercus* sp. wood in cloud forest (ITCV, JDR).

NOTES: Mexican material assignable to *Xylaria apiculata* Cooke, apparently is rare and largely confined to temperate places. Rogers and Samuels (1986) described and depicted a somewhat similar culture of *X. arbuscula* (see their Fig. 9E). Their fungus did not form stromata in culture.

Xylaria duranii San Martín et Vanoye sp. nov.

Figs. 5, 6, 7, 8

Stromata non ramosa, filiformes, aggregatis peritheciis fere liber, in stipitibus villosus. Apicibus sterilibus, acutatis, brevis, 1-2 cm longitudine tota x 1-1.5 mm crassi, extus nigella cum externo strato concoloro, intus alba. Textura potius mollis. Superficies laevis vel nodosus. Perithecia 0.3-0.4 mm diam. Ostiola aliquantum papillata vel hemispherica. Asci cylindrici, octospori, ordinate in parte biseriate, 96-118 μ m longitudine tota x 5-7.5 μ m crassi, partibus sporiferis 60-88 μ m, annulo apicali in liquore Melzeri cyanescente, rectangulare, 2.5 μ m alto x 1.5-2 μ m crasso. Ascosporae palliduseae brunneae vel brunneae, translucidae, ellipsoideo inequilaterales vel leniter lunatae cum extremis angustus vel late rotundatis, nonnulla extremum abrupte constrictis, 12-14.5 (-16) x 4-4.5 (-5) μ m, rima germinativa recta vel sigmoidea, longa praeditae.

Status anamorphosis ignotus.

Stromata unbranched, filiform, on villose stipes, with short, acute sterile apices, bearing crowded, almost free perithecia, 1-2 cm total length x 1-1.5 mm broad; externally black with a concolorous outer layer, internally white. Texture rather soft. Surface smooth to nodulose due perithecial contours. Perithecia 0.3-0.4 mm diam. Ostioles slightly papillate to papillate hemispherical. Asci cylindrical, eight-spored, with partly biseriate spore-arrangement, 96-118 μ m total length x 5-7.5 μ m broad, the spore-bearing part 60-88 μ m, with apical ring bluing in Melzer's iodine reagent, rectangular, 2.5 μ m high x 1.5-2.0 μ m broad. Ascospores brown to light-brown, translucent, ellipsoid-inequilateral to somewhat crescentic, with narrowly rounded to narrow ends, sometimes with one end pinched, 12-14.5 (-16) x 4-4.5 (-5) μ m, with germ slit straight to sigmoid full spore-length on concave side.

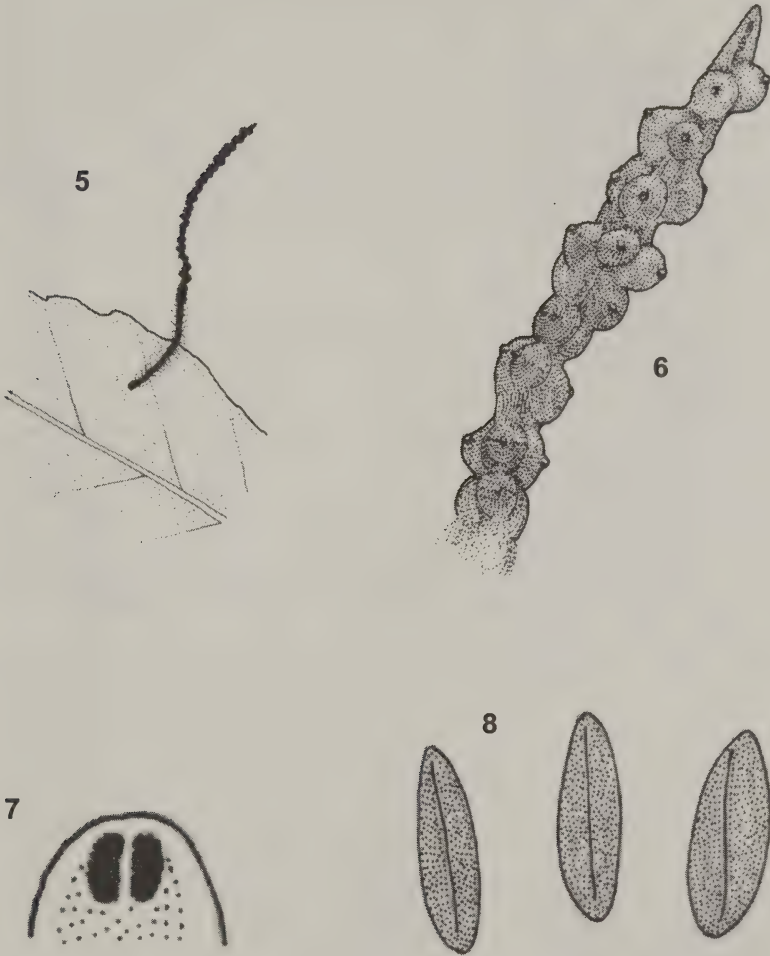
Anamorph unknown.

Xylaria duranii is named after the eminent mycologist and human rights advocate, our friend Rubén Durán.

SPECIMEN EXAMINED: Tamaulipas, Ciudad Victoria municipality, Cañón del Novillo, Los Indios ranch, 535 m, 9.XI.1998, Vanoye 165, on leaves and fruit remains of *Quercus polymorpha* Schl. et Cham. in an oak forest (ITCV: HOLOTYPE).

NOTES: Kar and Gupta (1978) reported as *X. trichopoda* Penzig & Sacc. a taxon growing on decaying fruits of *Quercus* sp. in India, describing ascospores as light-brown, 14-17.5 x 3.5-7 μ m. That collection seems close to the fungus described herein.

The original description of *Xylaria trichopoda* states that it grows on corticated wood not on leaves (for description of *X. trichopoda* see Penzig and Saccardo, 1904).



Figs. 5-8. *Xylaria duranii*. 5: Stroma, 1 cm = 3 mm. 6: Stroma detail showing crowded, almost free perithecia, 1 cm = 1.7 mm. 7: Ascus apical ring, 1 mm = 0.3 μ m. 8: Ascospores with sigmoid or straight germ slits, 1 cm = 5.5 μ m.

Xylaria juniperus Starb. var. **asperula** Starb., Ascom. d. Regn. Exp. II, Bihang t. k. Svenska Vet. Akad. Handlingar (Stockholm). 27: 20. 1901. Figs. 9, 10, 11, 12

Stromata unbranched, with short-clavate to clavate fertile part, 0.5-1.7 cm high x 1-3.5 mm broad, with acute, sometimes thread-like, sterile apices, on short to long, tomentose to villose stipes, 0.5-3 cm high; externally dull to shiny-black with white or brown to dark-brown peeling outer layer organized in longitudinal strips or patches, internally white. Texture hard, carbonous. Surface roughened by the outer layer, ostiola, and tomentum-like outgrowths when young. Perithecia 0.5-0.8 mm diam. Ostioles finely papillate to papillate-hemispherical. Asci cylindrical, eight-spored, uniseriate to partly biseriate, long-stipitate, 157-203 μ m total length x 6.5-9 μ m broad, the spore-bearing part 87-98 μ m, the apical ring bluing in Melzer's iodine reagent, rectangular, 4 μ m high x 2-3 μ m broad. Ascospores brown to dark-brown, ellipsoid-inequilateral to navicular with narrowly rounded ends, sometimes bearing a hyaline appendage at one end, (14-) 15-17 (-18) x (4.5-) 5-5.5 μ m, the germ slits straight, oblique to sigmoid, slightly less than spore-length on concave side.

Colonies covering Petri dish in 2-3 wk, at first white, with light-yellow or white entire margins, zonate or azonate, cottony, becoming brown with white sectors or turning black from the center outward, appressed, soon overlain by white, floccose mycelium. Reverse with dark-brown and unchanged areas. Stromata scarce to numerous, produced in localized sectors of the colony or over-all in concentric rings, acicular to clavate, with white, pointed tips, 0.4-1 cm high x 0.7-0.9 mm broad, branched to unbranched. Conidium-bearing regions produced on upper surfaces of stromata or on superficial tufts. Conidiogenous cells terminal, cylindric, hyaline, 6-19 x 2-3.5 μ m, bearing terminal and lateral denticular secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline (white in mass), smooth, cylindroid to somewhat fusiform, (4.5-) 5-7 (-8) x 1.5-2.5 μ m, the flattened bases indicating former points of attachment to conidiogenous cells.

SPECIMENS EXAMINED: Morelos, Cuernavaca municipality, La Pera curve, 2045 m, 18.IX.1998, San Martín 4122M, on **Quercus** wood in an oak forest (FSM); Cuernavaca municipality, La Pera curve, alt. 2230 m, 18.IX.1998, San Martín 4137M, on **Quercus** wood in an oak forest (FSM). Nuevo León, Guadalupe municipality, La Pastora forest, 15.X.88, Mario Angel Ibarra I, on **Quercus** sp. wood in an oak forest (ITCV). Tamaulipas, no date, San Martín 6017T, on **Quercus** sp. wood (FSM); Gómez Fariás municipality, Rancho El Cielo, 9.X.86, Jesús García 5337, on fallen fruit of **Quercus** sp. (ITCV); Gómez Fariás municipality, El Malacate, 13.VIII.1988, S. Chacón-Jiménez 456 (CULTURED) on **Quercus** sp. wood in cloud forest (ITCV).

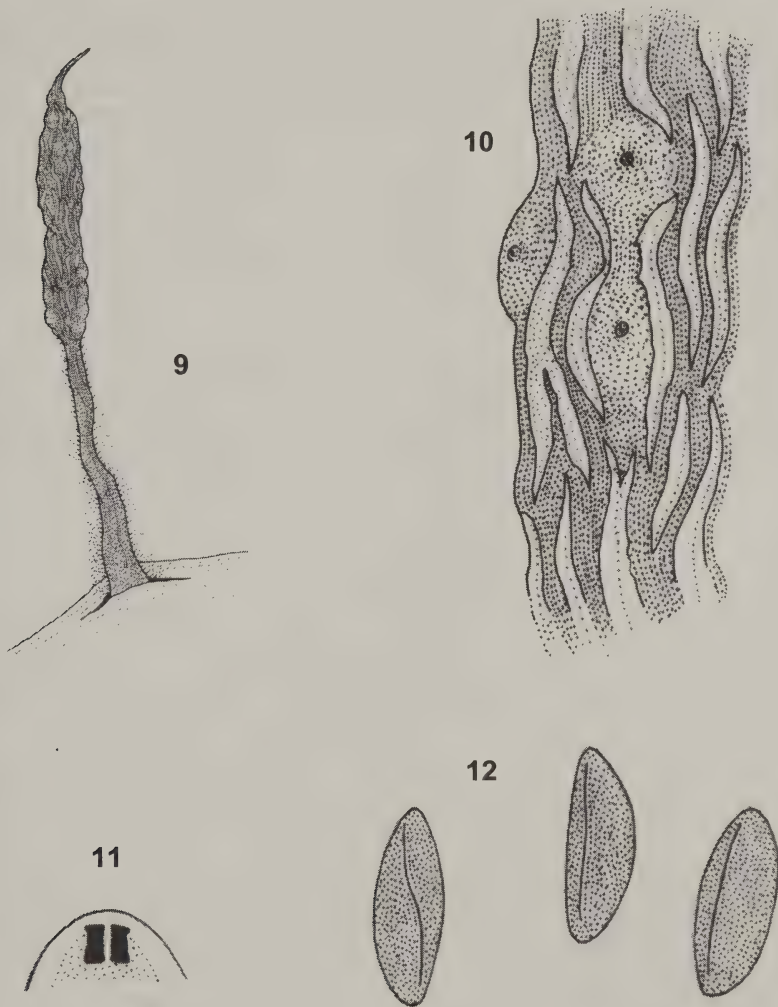
ADDITIONAL SPECIMEN EXAMINED: **Xylaria juniperus** Starb. var. **asperula** Starb., Paraguay, Mbopy, 9.II.1893. Malme s. n. (S: SYNTYPE).

NOTES: Collection Jesús García 5337 fits syntype of **Xylaria juniperus** Starb. var. **asperula** Starb. The rest show a white outer peeling layer, but have in common with typical **X. juniperus** var. **asperula** the ascospore shape and size, and a long, straight to sigmoid germ slit running almost the full length of the ascospore.

Xylaria juruensis Hennings described by San Martín and Rogers (1989) and **X. arbuscula** Sacc. var. **plenofissura** Ju & Tzean as described by Ju and Tzean (1985), fit the concept of **X. juniperus** var. **asperula**.

A member of the **arbuscula** complex reported by Candoussau (1983), collected in the Pyrenees on **Quercus** sp. wood, seems conspecific with the Mexican material (see fig. 3 in Candoussau, 1983).

Xylaria juniperus var. *asperula* is close to *Xylaria apiculata* Cooke. The latter taxon is treated here as material with stromatal features much like those of *X. arbuscula*, and with ascospores 20 μm or larger. *Xylaria juniperus* var. *asperula* is a member of the vast *Xylaria arbuscula* complex.



Figs. 9-12. *Xylaria juniperus* var. *asperula*. 9: Stroma, 1 cm = 2 mm. 10: Stroma detail showing discrete perithecial contours and finely papillate to papillate-hemispherical ostioles, 1 cm = 1 mm. 11: Rectangular ascus apical ring, 1 mm = 1 μm . 12: Ascospores with straight, oblique to sigmoid germ slits, 1 cm = 8 μm .

Xylaria longiana Rehm, Ann. Mycol. 2: 175. 1904.

Stromata are much like as described by San Martín and Rogers (1989) as **Xylaria** cf. **longiana**. Stromata on ill or well-defined stipes, with blunt or acute sterile apices, bearing conspicuous or immersed perithecial contours. Surface with remnants of a white to brown peeling outer layer split in longitudinal strips or remaining as minute patches. Ostioles umbilicate to papillate-hemispherical. Ascospores (9-) 9.5-12 x 4-5.5 μm .

Colonies covering Petri dish in 3-4 wk, at first white with lobate to wavy margins, appressed, then with orange-buff, more or less cottony areas corresponding to primordia of stromata. Reverse brownish. Stromata densely arranged in concentric rings, cylindric, unbranched to branched at points of contact with Petri dish lid, terete, tomentose, black with palmate or more or less acute pinkish tips, 1-3.5 cm high x 2-2.5 mm broad. Conidium-bearing regions on upper surfaces of stromata. Conidiophores in upright palisades, irregularly branched, hyaline, smooth. Conidiogenous cells terminal, cylindrical, 16-28 x 3-5.5 μm , hyaline, bearing terminal and lateral denticulate conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline (white collectively), smooth, fusiform, 6-7 (-8) x 2.5 μm , with flattened bases indicating former points of attachment to conidiogenous cell. Conidia germinating in water.

SPECIMENS EXAMINED: Jalisco, Tequila municipality, Km 20 Tequila-Cerro de Tequila country road, 1800 m, 29.VIII.85, Guzmán-Dávalos 2558, on wood in oak forest (IBUG). Morelos, west side of La Pera curve, México-Cuernavaca freeway, 2300 m., 21.IX.69, Guzmán 7715, on wood in mixed forest of **Quercus** spp. with tropical elements (XAL); Tepoztlán municipality, La Pera curve, 8 km from Tepoztlán, 2100 m, 23.VIII.1998, San Martín 4039M, on **Quercus** sp. wood in an oak forest (FSM); Cuernavaca municipality, 2260 m, 18.IX.1998, San Martín 4113M & 4133M on **Quercus** sp. wood in an oak forest (FSM). Nuevo León, Iturbide municipality, ejido La Purísima, El Charco, 1700 m., 21.VIII.86, Fortunato Garza 725, on **Quercus** sp. wood in oak-pine forest (CFNL); Santiago municipality, 3 Km before Corral de Piedra, 3.X.85, Fortunato Garza 588, on dead log of **Quercus ryzophylla** Weath. in oak-pine forest (CFNL); Santiago municipality, El Cercado, 26.VI.88, Moreno 220, on **Quercus** sp. wood in submontane scrub with **Quercus** spp. (ITCV, JDR); Santiago municipality, El Cercado, 23.X.88, San Martín 1149 (CULTURED), on **Quercus** sp. wood in submontane scrub with **Quercus** spp. (ITCV, JDR); Garza García municipality, Chipinque, 1.XI.80, Mario Olguín 1, on wood in oak-pine forest (ITCV). State of México, Santa María Mazatla, 17.XII.88, Barbosa 40B, on wood in **Quercus** spp. forest (XAL). Tamaulipas: Gómez Fariás municipality, ejido Julilo, 13.VII.88, S. Chacón 460, on wood in cloud forest (ITCV); Hidalgo municipality, ejido Conrado Castillo, VII.87, San Martín 451, on wood in cloud forest (ITCV, JDR); Hidalgo municipality, ejido Conrado Castillo 2.V.88, Lucrecia García 103, 109 & 111, on wood in oak-pine forest (ITCV, JDR); Ciudad Victoria municipality, 5.IX.88, San Martín 1010 (CULTURED), on dead leaves of **Agave furcroides** Lem. "henequén" in an abandoned **Agave furcroides** plantation (ITCV, JDR); Ciudad Victoria municipality, El Madroño, 1450 m, 12.X.1995, San Martín 5193T, on **Quercus** wood in oak forest (ITCV); Ciudad Victoria municipality, Cañón del Novillo, Las Minas, 640 m, 1.X.1996, San Martín 5258T, on **Quercus** sp. wood in pine-oak forest (ITCV).

Collection San Martín 1010 on **Agave furcroides** yielded a somewhat different culture compared to cultures obtained from specimens growing on **Quercus** wood:

Colonies covering Petri dish in 2-4 wk, at first white, with entire margins, floccose, becoming pinkish in some areas. Reverse uncolored. Stromata produced over all the colony without any organized pattern, at first acicular then somewhat lanceolate, 3-4 cm high x 1-1.5 mm broad, branched to unbranched, at first white, becoming blackish from bases upward, with sparse tomentum. Conidium-bearing regions on the surface of stromata. Conidiophores in upright palisades, unbranched to sparingly branched, hyaline. Conidiogenous cells terminal, cylindrical, hyaline, 23-26 μm long x 2-3 μm broad, bearing terminal denticulate conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline (white in mass), smooth, fusiform, (4-) 5-6 (-7) x (1.5-) 2 μm , with flattened bases indicating former points of attachment to conidiogenous cell. Conidia on stromata from nature hyaline, fusiform, 4.5-5 x 1.5 (-2) μm , with flattened bases.

NOTES: It is clear that *X. longiana* has a distribution almost restricted to areas where oaks are present. The type was collected in Texas, USA, on *Quercus* wood (Rehm, 1904). Collection San Martin 1010, found on *Agave furcroides* leaves, has stromata that are smaller than material collected from *Quercus* wood, and produces floccose colonies, but is hardly separable from typical *X. longiana* on ascospore and conidial features.

The Mexican material is slightly variable in teleomorphic characters, but shows marked cultural differences perhaps as a reflection of host specialization. The fusiform shape that characterizes the conidia of *X. longiana* (and perhaps the whole *X. hypoxylon* complex), was reported by Chacko and Rogers (1981) from an Oklahoma collection designated *X. hypoxylon* (L.: Hook.) Grev. "small-spored collection". That fungus is referable to *X. longiana*.

Xylaria cf. *magnoliae* J. D. Rogers, Can. J. Bot. 57: 941. 1979. Figs. 13, 14, 15, 16

Stromata unbranched or branched, cylindrical, terete or compressed, tomentose, bearing perithecia with more or less evident contours, apices acute sterile, on ill-defined, conspicuously tomentose stipes, up to 7 cm total length x 2-4 mm broad; externally dark-brownish to blackish, internally white. Texture soft to somewhat woody. Surface roughened by perithecial contours, wrinkles, and the tomentum. Perithecia 0.3-0.7 mm diam. Ostioles finely papillate. Asci eight-spored, with uniseriate to partly biseriate spore arrangement, cylindrical, long-stipitate, 112-150 μm total length x 4-6.5 μm broad, the spore-bearing part 59-75 μm , the apical ring bluing in Melzer's iodine reagent, rectangular, 2-3 μm high x 1.5-2 μm broad. Ascospores yellowish, unicellular, ellipsoid-inequilateral to fusoid or crescentic, smooth, 10-13 (-14) x (2.5-) 3-4 μm , the germ slits obscure.

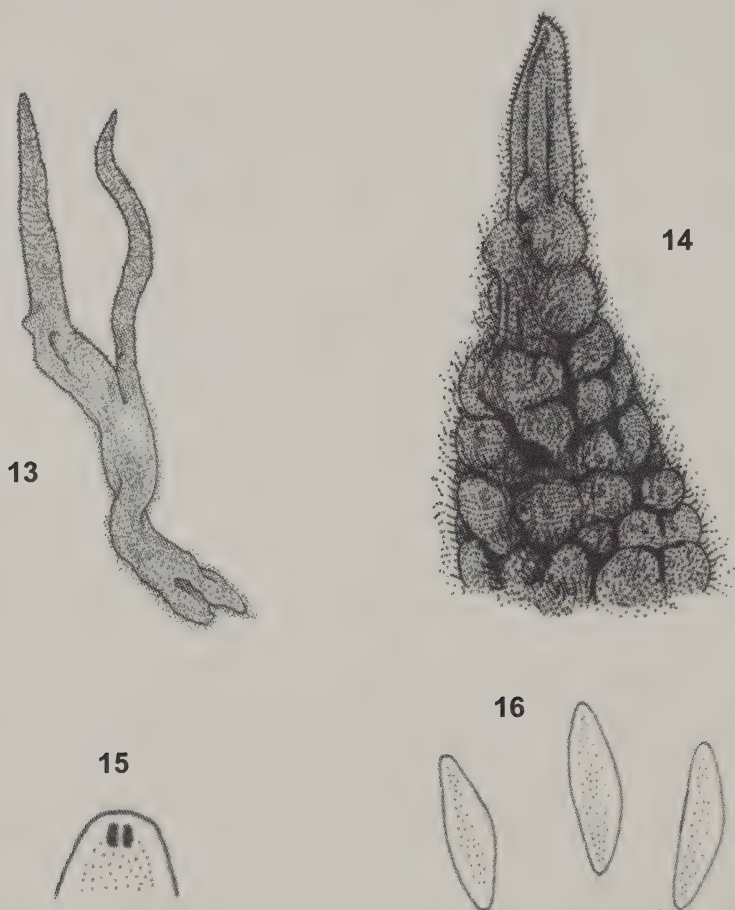
Anamorph unknown.

SPECIMEN EXAMINED: Nuevo León, Zaragoza municipality, La Encantada, 2500 m., Garza-Ocañas 608, on *Quercus* sp. wood in oak-pine forest (ITCV, CFNL).

NOTES: This fungus has stromatal surface characteristics, and ascospore shape and color similar to *X. magnoliae*, but grows on *Quercus* wood and has less pronounced perithecial contours and slightly smaller ascospores. It might represent a new variety of *X. magnoliae* but unfortunately cultures were not obtain.

Xylaria michoacana San Martín, J. D. Rogers et Lavín sp. nov. Figs. 17, 18, 19, 20

Stromata peltata vel subglobosa, subsessile, substratum affixis ad angustus connexum, 1-1.5 cm longa x 7-8 mm crassi x 4-9 mm alta, extus nigella cum externo strato albo, intus albida sordida. Textura potius dura. Superficies laevis cum ostiolis et fissuris. Perithecia 0.4-0.9 mm diam. Ostiola papillata, haemisphaerica. Asci cylindrici, octospori, ordinate uniseriate vel in parte biseriata, cum longissimo stipite, 234-309 μ m longitudine tota x 19-22 μ m crassi, partibus sporiferis 140-164 μ m, annulo apicali in



Figs. 13-16. **Xylaria** cf. **magnoliae**. 13: Stroma branched, compressed, and tomentose, 1 cm = 8 mm. 14: Stroma detail with tomentum and perithecial contours, 1 cm = 1 mm. 15: Rectangular ascus apical ring, 1 mm = 1 μ m. 16: Ascospores fusoid or crescentic with inconspicuous or absent germ slit, 1 cm = 4.7 μ

liquore Melzeri cyanescente, discoideo vel leniter rectangulare, 1.5-2 μm alto x 4-6 μm crasso. Ascospores fuscae vel quasi nigra, subglobosa omni extremo abrupte constrictis, (20.5-) 21.5-24.5 (-25) x (13.5-) 14-16 (-18.5) μm , rima germinativa sigmoidea vel spirali, longa praeditae.

Stromata peltate to subglobose, sessile, attached to substrate by a narrow connective, 1-1.5 cm long x 7-8 mm wide x 4-9 mm high; externally blackish with white outer crust, internally dirty white. Texture rather hard. Surface smooth with ostioles and cracking. Perithecia 0.4-0.9 mm diam. Ostioles papillate-hemispherical. Asci cylindrical, eight-spored, with uniseriate to partly biseriate spore arrangement, long-stipitate, 234-309 μm total length x 19-22 μm , the spore-bearing part 140-164 μm , the apical ring bluing in Melzer's iodine reagent, discoid to somewhat rectangular, 1.5-2 μm high x 4-6 μm broad. Ascospores dark-brown to almost black, subglobose with abruptly pinched ends, (20.5-) 21.5-24.5 (-25) x (13.5-) 14-16 (-18.5) μm , with sigmoid to spiral germ slits.

This fungus is named after the Mexican state of Michoacán.

Colonies covering Petri dish in 3-4 weeks, at first white, with somewhat entire margins, azonate, floccose, becoming dark-green to black from center outwards. Stromata arising over the entire colony in more or less concentric fashion, at first dark-green finally black, tomentose all-over, clavate, prostrate to upright, 0.5-0.8 mm high. No anamorphic structures produced.

SPECIMEN EXAMINED: Michoacán, Pátzcuaro municipality, Km 6 Pátzcuaro-Santa Clara del Cobre road, V.III.88, Jesús García 6005, on *Quercus* sp. wood in cloud forest (ITCV: HOLOTYPE; JDR: ISOTYPE).

NOTES: This highly distinctive penzigoid fungus is a *Xylaria* based upon cultural features. Its stromatal shape and type of ostioles are close to those of *Penzigia macrospora* Penzig & Sacc. as described by Rogers et al. (1987), but the latter has ellipsoid to navicular ascospores, 29.4-35.3 x (11.8-) 17.6-20.6 μm , straight germ slits, and cultures did not form stromata. Apparently the above-described material is a taxon rarely collected in México and perhaps restricted to species of *Quercus* of the cloud forest of western Michoacán.

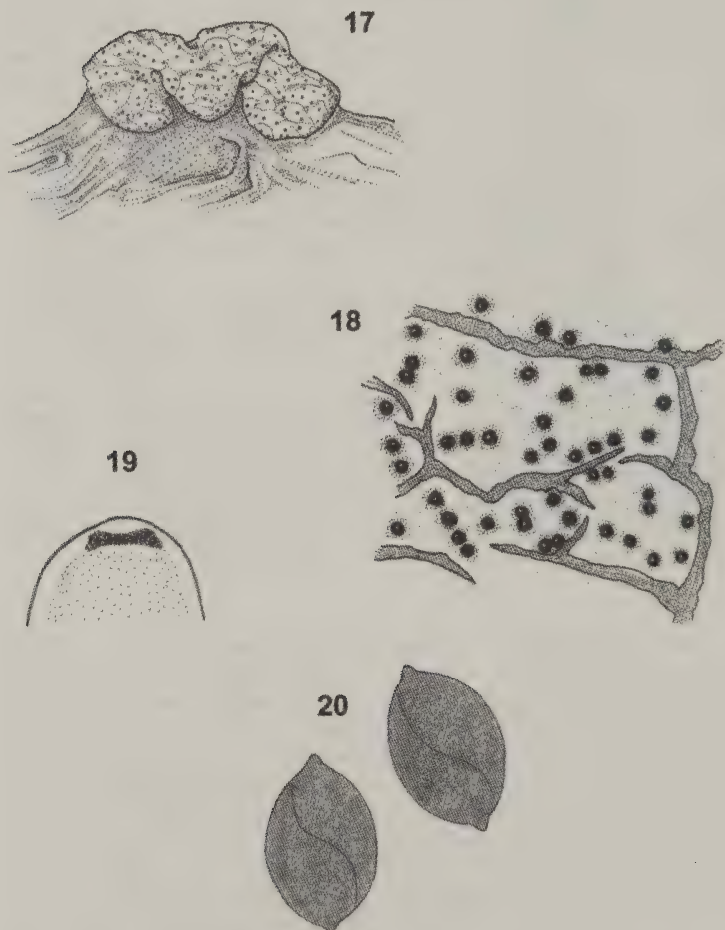
Xylaria quercinophila San Martín, J. D. Rogers et Lavín sp. nov. Figs. 21, 22, 23, 24

Stromata non ramosa, conica vel irregularia, tumulis peritheciorum inconspicuis, apicibus rotundatis fertilibus, stipitibus longis vel brevis, robustis rufobrunneis, fundis pannosis et spongiosis praedita, 2-7 cm longitudine tota x 0.5-3 cm crassa, extus alba vel luteola cum ostioliis nigellis et fissuris tenuibus; intus albidia subinde peritheciis intus endostromata. Textura valde dura. Superficies laevis praeter rugae et inflexae. Perithecia 0.5-1 mm diam. Ostiola parce papillata. Asci cylindrici, octospori, stipitati, 232-276 μm longitudine tota x 8.5-12 μm crassi, partibus sporiferis 156-170 μm , annulo apicali in liquore Melzeri cyanescente, quadrato vel aliquantum cuneato, 3.5-4 μm alto x 2.5-3.5 μm crasso. Ascospores fuscae, ellipsoideo inequilaterales cum extremis rotundatis vel late rotundatis, laeves, (19-) 20-23 (-25) x 8-9.5 (-10) μm , rima germinativa spirali longa praeditae.

Status anamorphosis ignotus.

Stromata unbranched, conical to irregular with rounded fertile apices, on short to long, stout, reddish-brown, pannose and spongy stipes, 2-7 cm total length x 0.5-3 cm broad, externally white to yellowish with black ostioles and fine cracks, internally whitish,

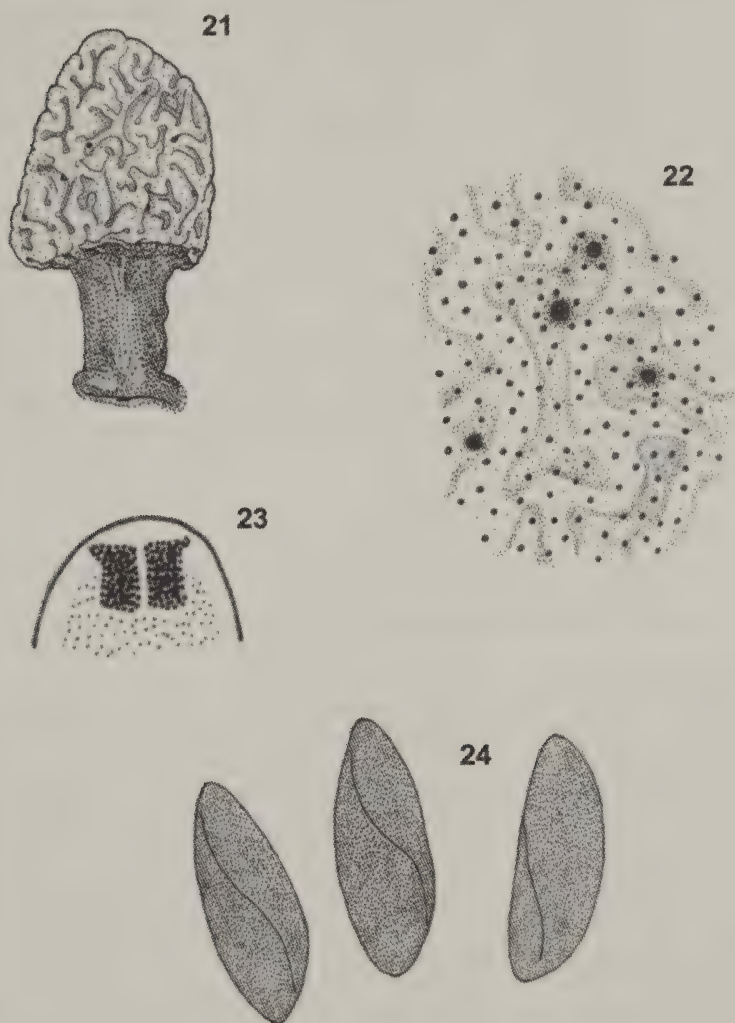
sometimes with perithecia deep within the flesh. Texture very hard. Surface smooth except for wrinkling and infolding. Perithecia 0.5-1 mm diam. Ostioles slightly raised. Asci cylindrical, eight-spored, stipitate, 232-276 μm total length x 8.5-12 μm broad, the spore-bearing part 156-170 μm , the apical ring bluing in Melzer's iodine reagent, quadrate to slightly cuneate, 3.5-4 μm high x 2.5-3.5 μm broad. Ascospores dark-brown, ellipsoid-inequilateral with broadly or narrowly rounded ends, smooth, (19-) 20-23 (-25) x 8-9.5 (-10) μm , with spiralling germ slits.



Figs. 17-20. *Xylaria michoacana*. 17: Stroma peltate, 1 cm = 3.5 mm. 18: Stroma detail showing papillate-hemispherical ostioles, 1 cm = 4 mm. 19: Discoid to somewhat rectangular ascus apical ring, 1 mm = 1 μm . 20: Subglobose ascospores with abruptly pinched ends, 1 cm = 7.5 μm .

Anamorphic state unknown.

The specific name refers to the preference of this taxon for *Quercus* spp. wood.



Figs. 21-24. *Xylaria quercinophila*. 21: Stroma, 1 cm = 8.5 mm. 22: Stromatal surface detail, 1 cm = 2.7 mm. 23: Ascus apical ring, 1 mm = 1 μ m. 24: Ascospores with spiralling germ slits, 1 cm = 7.5 μ m.

SPECIMENS EXAMINED: Jalisco, Autlán municipality, Manantlán Biosphere Reserve, Las Joyas, 1900 m, IX.85, Fanti 505, on wood in cloud forest (IBUG); Cucutitlán municipality, Mesa de San Miguel, 2400 m., 14.IX.82, Nieves-Vázquez 93, (IBUG); Gómez Farías municipality, La Calavera, 15.VIII.81, Trujillo-Flores 262, in forest of *Pinus-Quercus* (XAL). Nuevo León, Villa de Juárez municipality, Rincón de la Sierra, Jesús García 7, on wood in *Quercus* spp. forest with *Sargentia* sp. (ITCV). Querétaro, Jalpa municipality, 6 km after La Yerbabuena, 17.VIII.1996, Jesús García 9848, on *Quercus* sp. wood in cloud forest (ITCV). Tamaulipas, Hidalgo municipality, ejido Conrado Castillo, VII.87, Avalos 25 (ITCV: HOLOTYPE; JDR: ISOTYPE); Gómez Farías municipality, El Cielo Biosphere Reserve, 1100 m., 8.VII.84, Martínez 26, on wood in cloud forest (ITCV, JDR); Gómez Farías municipality, El Cielo Biosphere Reserve, 1100 m, 22.VII.88, S. Chacón 370, on wood in cloud forest (ITCV, JDR); Gómez Farías municipality, El Cielo Biosphere Reserve, San José, 4.X.1992, San Martín 1550T, on *Quercus* sp. wood in cloud forest (ITCV); Tula municipality, Tula-Ocampo road, 8.X.90, Moreno 401C, on wood in *Quercus* spp. forest (ITCV). Veracruz, Atoyac, 9.VII.83, A. Ruíz, on humus (sic) (XAL).

NOTE: The gross stromatal morphology of this fungus is reminiscent of *X. platypoda* (Lév.) Fr. but the latter has a somewhat farinose outer crust, more or less prominent perithecial contours, and larger ascospores (see Dennis, 1956 for description of *X. platypoda*). *Xylaria quercinophila* apparently occurs only in México and is restricted to species of *Quercus*.

Xylaria cf. *scruposa* (Fr.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 127. 1851.

Teleomorphic stromata is as described by San Martín and Rogers (1989) as *X. cf. corniculata*.

Anamorph unknown.

SPECIMENS EXAMINED: Chiapas, Jaltenango municipality, El Triunfo Hill, 8.VI.88, San Martín 633, 660 & 694; 9.VI.88, San Martín 736, on wood in cloud forest with *Quercus skinneri* Benth. (ITCV). Hidalgo, between Huautla de Hidalgo and Huejutla de Reyes, XII.1969, Díaz-Moreno, on wood of ?*Taxodium* sp. "ahüehüete" in cloud forest (ENCB). Jalisco, Autlán municipality, Manantlán Biosphere Reserve, Las Joyas, 1900 m, 14.X.85, Guzmán-Dávalos 2888, (IBUG); Autlán municipality, Manantlán Biosphere Reserve, Las Joyas, 1900 m, 15.X.85, Guzmán-Dávalos 2984, on wood in cloud forest (IBUG). Tamaulipas, Gómez Farías municipality, El Cielo Biosphere Reserve, 1100 m, 12.VIII.88, S. Chacón 444, on wood in cloud forest (ITCV); ejido Julilo, 1.XI.87, S. Chacón 49, on wood in cloud forest (ITCV); Gómez Farías municipality, San José, 3.X.1992, San Martín 1507, on wood of *Quercus* sp. "encino roble" in cloud forest (ITCV); Gómez Farías municipality, San José, 4.X.1992, San Martín 1503, on *Quercus* sp. wood in cloud forest (ITCV); Gómez Farías municipality, San José, 6.X.1994, San Martín 1519T and 6018T, on *Quercus* sp. wood (ITCV).

NOTES: Collections listed above are forms of the tropicals *X. scruposa* (Lloyd, 1923) or *X. moelleroclavus* (Rogers, et al., 1997), that have evolved in cloud forests associated with oak wood. In San Martín and Rogers (1989) these taxa were called *X. cf. corniculata* following Saccardo (1906), because of the absence of a verrucose surface and presence of sigmoid to spiral germ slits running the full-length of the ascospores.

***Xylaria* sp. *cubensis* complex.**

Stromata clavate, branched or unbranched at base, with rounded fertile apices, on short or long fluted stipes arising from a pannose base, 1.5-2.5 cm total length x 4-6 mm broad, externally copper-colored, blackish in age; internally white, becoming hollow. Texture hard. Surface smooth except for fine wrinkles and ostioles. Perithecia 0.3-0.5 mm diam. Ostioles finely papillate. Asci eight-spored, cylindrical, long-stipitated, 105-195 μ m total length x 5-6 μ m broad, the spore-bearing part 50-69 μ m long, the apical ring bluing in Melzer's iodine reagent, quadrate to rectangular, 2-3 μ m high x 2 μ m broad. Ascospores brown, ellipsoid-inequilateral with broadly or narrowly rounded ends, (8.5-) 9-11 (-12) x 4-5 μ m, the germ slits straight, spore-length.

Anamorph unknown.

SPECIMENS EXAMINED: Guanajuato, km 82 Guanajuato-Dolores Hidalgo road, 29.XI.1994, San Martín 5199G, on *Quercus* wood in oak forest (ITCV). Jalisco: Autlán municipality, Cacoma Mountains near Agua Blanca, alt. 2297 m, 7.III.82, Nieves Hernández 56, on wood of ?*Abies* sp. (IBUG); Mazamitla municipality, Km 5 from Manzanilla de la Paz to Mazamitla, 6.X.84, Guzmán-Dávalos 1729, on wood in pine-oak forest (IBUG). Morelos, Cuernavaca municipality, La Pera curve, alt. 2255 m, 18.IX.1998, San Martín 4131M, 4141M & 5219M, on *Quercus* wood in oak forest (FSM). Tamaulipas, Hidalgo municipality, ejido Conrado Castillo, 2.V.88, Lucrecia García 102, on *Quercus* sp. wood in a transitional area from pine to cloud forest (ITCV, JDR); Llera municipality, ejido Loma Bonita, XI.87, S. Chacón 111, on *Quercus* sp. wood in pine-oak forest (ITCV, JDR). Veracruz, Banderilla municipality, La Martinica ranch, alt. 1340 m, 7.IX.84, Guzmán-Dávalos 1421, on wood (IBUG).

ADDITIONAL SPECIMEN EXAMINED: *Xylaria laevis* Lloyd. Solomon Islands: Russell Island, E. Cheel, Cat. # 12465 (BPI: TYPE).

NOTES: This taxon belongs to *Xylaria cubensis* complex. It differs from typical *X. cubensis* in the slightly longer (average) ascospores with conspicuous germ slits, and in being restricted to *Quercus* spp. wood.

The Mexican fungus was considered to be possibly *X. laevis* Lloyd by San Martín and Rogers (1989), due the great resemblance of its hollow stromata with *X. nigrescens* (Sacc.) Lloyd. Lloyd (1918) considered *X. laevis* a small-spored form of *X. nigrescens*. Examination of type material, however, shows *X. laevis* to have ascospores with acute ends, 7-8.5 (-9) μ m long which invariably bear a cellular appendage on one end, thus differing from those described by San Martín and Rogers (1989).

Xylaria* sp. aff. *hypoxylon

Figs. 25, 26, 27, 28

Stromata unbranched or branched, cylindric to irregular, terete to compressed, on ill- or well-defined, tomentose stipes, with acute sterile apices, bearing conspicuous or inconspicuous perithecial contours, 3.5-4 cm high x 2 mm broad; externally blackish with white to brown peeling outer layer organized in longitudinal strips, internally white. Texture hard. Surface roughened by the outer layer and ostioles. Perithecia 0.35-0.5 mm diam. Ostioles slightly papillate to conical. Asci cylindrical, eight-spored, uniseriate to obliquely uniseriate, 113-140 μ m total length x 5.5-7 μ m broad, the spore-bearing part 65-75 μ m, the apical ring bluing in Melzer's iodine reagent, cubic, 2-2.5 μ m high x 2 μ m broad. Ascospores brown to dark-brown, ellipsoid-inequilateral to navicular with narrow to narrowly rounded ends, (9-) 9.5-11 (-12) x 4.5-5 μ m, the germ slits straight full spore-length.

Colonies covering Petri dish in 4 wk, at first grayish-white, then gray and white with ray-like growths and concentric rings, appressed. Reverse yellowish, the agar furrowed. Stromatal primordia produced as hump-like growths in a concentric pattern, never upright. Anamorphic structures not produced.



Figs. 25-28. *Xylaria* sp. aff. *hypoxylon*. 25: Stroma, 1 cm = 5 mm. 26: Stroma detail, 1 cm = 5 mm. 27: Ascus apical ring, 1 mm = 0.3 μ m. 28: Ascospores with straight germ slits, 1 cm = 5.5 μ m.

SPECIMENS EXAMINED: Tamaulipas: Hidalgo municipality, ejido Conrado Castillo, VII.88, Lucrecia García 113 (CULTURED), on *Quercus* sp. wood in cloud forest (ITCV); same data as above, Lucrecia García 114, 115 & 120, on *Quercus* sp. wood in cloud forest (ITCV).

NOTE: Mexican material has smaller ascospores than those of *X. hypoxylon*, i.e. (9-) 9.5-11 (-12) x 4.5-5 μm vs 12-16 x 5-6.5 μm (*teste* Rogers, 1986) and cultures were as those of *Xylaria hypoxylon* collected in the Pacific Northwest of United States of America (Y.-M. Ju, unpublished data).

It is interesting to note that both stromata with conspicuous and inconspicuous perithecial contours, can be found in the same collection.

Xylaria sp. aff. *longiana* Rehm, Ann. Mycol. 2: 175. 1904. Figs. 29, 30, 31, 32

The teleomorph is much like that described by San Martín and Rogers (1989) for *Xylaria* cf. *longiana* Rehm. Stromata terete to flattened with white outer peeling layer split in strips. Perithecia 0.2-0.3 mm diam. Asci 159-174 μm total length x 6-7 μm broad, the spore-bearing part 82-89 μm , the apical ring bluing in Melzer's iodine reagent, quadrate to urn-shaped, 2-3 (-3.5) μm high x 2-2.5 μm broad. Ascospores ellipsoid-inequilateral to navicular with narrow ends, (12-) 13-14.5 (-15) x 5-5.5 μm , the germ slits straight spore-length or nearly so on concave side.

Anamorph unknown.

SPECIMEN EXAMINED: Jalisco, Tequila municipality, Km 20 Tequila-Cerro de Tequila country road, 2800 m, 29.VIII.85, Guzmán-Dávalos 2561, on *Quercus* wood in oak forest (IBUG).

NOTE: This fungus shares with *X. longiana* a habitat where oaks are a common component of the flora and the same type of stromatal surface and ostioles, but differs in its larger ascospores i. e. (12-) 13-14.5 (-15) μm vs (9-) 9.5-12 μm . It might be a new taxon but unfortunately its anamorph is unknown.

Xylaria subcoccophora San Martín et Lavín sp. nov. Figs. 33, 34, 35, 36

Stromata cylindrici, tumulis perithecorum inconspicuis vel conspicuis, apicibus sterilibus longis vel brevis, stipites glabro, curtum, 1.5-3 cm longitudine tota x 2 mm crassi, extus nigella cum externo strato albo delapso, intus albida. Textura satis dura. Superficies laevis excipere tumulis perithecorum et strato externo. Perithecia 0.3-0.6 mm diametro. Ostiola leniter papillata. Asci cylindrici, octospori, longi-stipitati, 127-178 μm longitudine tota x 5-6 μm crassi, partibus sporiferis 44-60 μm , annulo apicali in liquore Melzeri cyanescente, quadrato, 2 x 2 μm . Ascosporae brunneae vel fuscae, unicellulares, ellipsoideo inequilaterales vel naviculares cum extremum late rotundatis, (9-) 10-11 (-11.5) x 4-5 μm , rima germinativa recta leniter minus longitudinem sporae, in latus concavus.

Status anamorphosis ignotus.

Stromata cylindrical bearing inconspicuous to conspicuous perithecial mounds, with long or short acute sterile apices, on short, glabrous stipes, 1.5-3 cm total length x 2 mm broad; externally blackish with a white peeling outer layer; internally white. Texture fairly hard. Surface smooth except for perithecial contours and peeling layer. Perithecia 0.3-0.6 mm diam. Ostioles slightly papillate. Asci cylindrical, eight-spored, long-stipitate 127-178 μm total length x 5-6 μm broad, the spore-bearing part 44-60 μm , with apical ring bluing in Melzer's iodine reagent, quadrate, 2 x 2 μm . Ascospores brown to dark-

brown, unicellular, ellipsoid-inequilateral to navicular with narrowly rounded ends, (9-) 10-11 (-11.5) $\times$ 4-5 μm , the straight germ slits less to nearly full spore-length, on concave side.

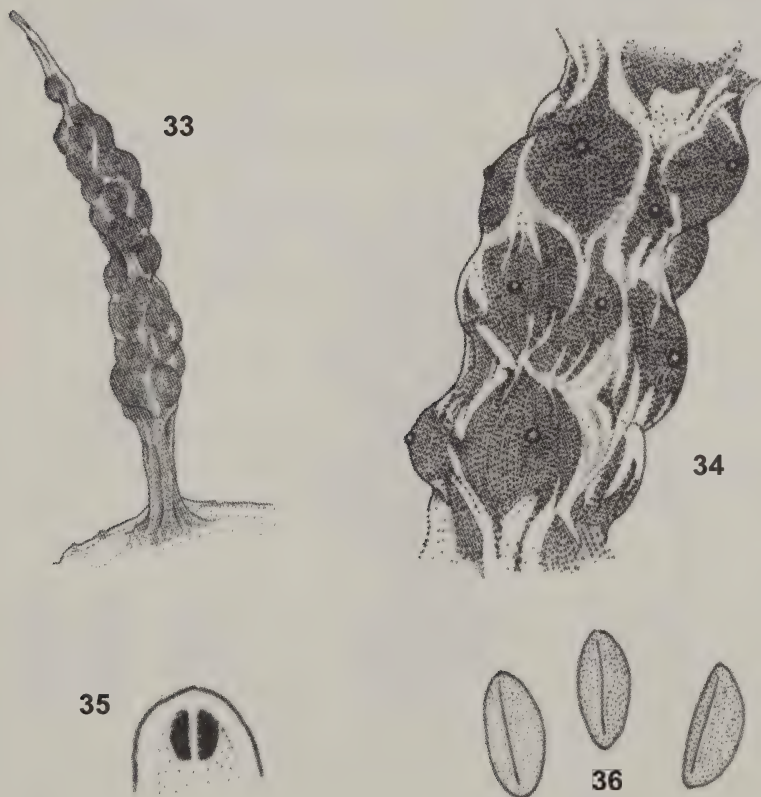


Figs. 29-32. *Xylaria* sp. aff. *longiana*. 29: Stroma, 1 cm = 6 mm. 30: Stroma detail showing the surface with remnants of a white outer layer, 1 cm = 1 mm. 31: Quadrate apical ring, 1 mm = 0.5 μm . 32: Ascospores with straight germ slits, 1 cm = 5.3 μm .

Anamorphic state unknown.

The specific uninomial of this taxon relates its less prominent perithecial mounds as compared with typical *X. coccophora* Mont.

SPECIMENS EXAMINED: Tamaulipas: Gómez Farías municipality, 1.XI.1987, ejido Alta Cima, S. Chacón-Jiménez 40, 42, 43, 44 & 192, on *Quercus* sp. wood in cloud forest (ITCV, FSM, JDR); Gómez Farías municipality, ejido Julilo, 13.VIII.1988, S. Chacón-Jiménez 461, on *Quercus* wood in cloud forest (ITCV); Gómez Farías municipality, 4.X.1992, San Martín 1506T, on *Quercus* sp. wood in cloud forest (FSM: HOLOTYPE); Gómez Farías municipality, El Malacate, 13.VIII.1988, S. Chacón-Jiménez 451, 458, 459 & 462 (ITCV); Gómez Farías municipality, El Cielo Biosphere Reserve, 1100 m, S. Chacón-Jiménez 372, on *Quercus* sp. wood in cloud forest (ITCV, JDR); Gómez Farías municipality, El Cielo Biosphere Reserve, 1065 m, S. Chacón-Jiménez 450 & 453, on *Quercus* sp. wood in cloud forest (ITCV).



Figs. 33-36. *Xylaria subcoccophora*. 33: Stroma, 1 cm = 4 mm. 34: Stroma detail showing conspicuous perithecial mounds, 1 cm = 0.7 mm. 35: Ascus apical ring, 1 mm = 0.35 μ m. 36: Ascospores, 1 cm = 0.8 μ m.

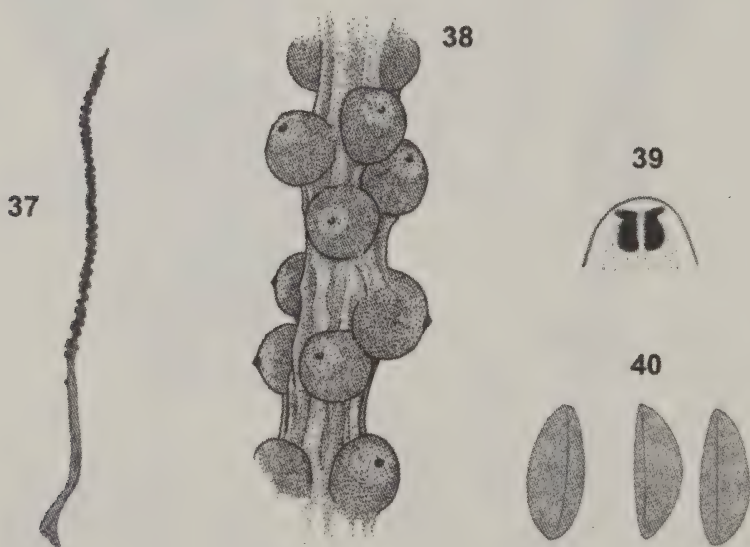
NOTES: This species is reminiscent of *X. coccophora* Mont., but the latter has stromata with conspicuous to almost free perithecial contours, a brown to yellow outer peeling layer, ascospores brown to light-brown, ellipsoid to somewhat allantoid with rounded to narrowly rounded ends, $10\text{--}11\text{--}(13) \times (3.5\text{--}) 4\text{--}(4.5) \mu\text{m}$, and thrives in tropical rain forests. The ascospore morphology of *X. subcoccophora* is like that of *X. arbuscula* Sacc., but stromatal features of the latter are quite different (for discussion on *Xylaria arbuscula-apiculata* complex see Candoussau, 1983 and San Martín, 1992).

Xylaria tumulosa San Martín, J. D. Rogers et Lavín sp. nov.

Figs. 37, 38, 39, 40

Stromata non ramosa vel ramosa, cum rachidibus longa, laevi, peritheciis conspicuis praedita, rachidibus extensa sursum et deorsum peritheciis, 6–16 cm longitudine tota x 1.5–2 mm crassa, extus nigella cum strato residuum brunneo; intus albida. Textura dura. Superficies laevis vel aliquantum verrucosa cum tumulis peritheciolorum et strata externa. Perithecia 0.8–1 mm diam. Ostiola inconspicua vel leniter papillata. Asci cylindrici, octospori, plumerumque uniseriate, stipitati, 116–212 μm longitudine tota x 7–9 μm crassi, partibus sporiferis 112–136 μm , annulo apicali in liquore Melzeri cyanescente, rectangulari, 4.5–5.5 μm alto x 2.5–3 μm crasso. Ascosporae brunneae, ellipsoideo inequilaterales vel naviculares apicibus angustatis (16.5–) 17–20 (–22) x (6–) 7–8 μm , rima germinativa abbreviata, in latere concavo praeditae.

Status anamorphosis ignotus.



Figs. 37–40. *Xylaria tumulosa*. 37: Stroma, 1 cm = 1.4 cm. 38: Stroma detail showing almost naked perithecia, 1 cm = 0.8 mm. 39: Ascus apical ring, 1 mm = 1 μm . 40: Ascospores, 1 cm = 7.5 μm .

Stromata unbranched or branched above stipes, with smooth, long rachis that extends upward as sterile apex and downward as stipe, bearing almost naked perithecia, 6-16 cm total length x 1.5-2 mm broad; externally black with remnants of dark-brown outer layer, internally white. Texture hard. Surface smooth to somewhat verrucose with perithecial contours, papillae, and remnants of outer layer. Perithecia 0.8-1 mm diam. Ostioles inconspicuous to slightly papillate. Asci cylindrical, eight-spored, with uniseriate spore arrangement, stipitate, 166-211 μm total length x 7-9 μm broad, the spore-bearing part 112-136 μm with apical ring bluing in Melzer's iodine reagent, rectangular, 4.5-5.5 μm high x 2.5-3 μm broad. Ascospores brown, ellipsoid-inequilateral to navicular with narrowly rounded ends, (16.5-) 17-20 (-22) x (6-) 7-8 μm , with straight germ slit slightly less than spore-length, on concave side.

Anamorphic state unknown.

The specific name of the Mexican taxon alludes its prominent, almost free, perithecial contours.

SPECIMENS EXAMINED: Chiapas, Jaltenango municipality, El Triunfo Hill, 8.VI.88, San Martín 630, 639, 646 & 666, on dicot wood in cloud forest with *Quercus skinneri* Benth. (ITCV, JDR); Jaltenango municipality, El Triunfo Hill, 11.VI.88, San Martín 821, on dicot wood in cloud forest with *Quercus skinneri* Benth. (ITCV: HOLOTYPE; JDR: ISOTYPE); 891 on dicot wood in cloud forest with *Quercus skinneri* Benth. (ITCV, JDR).

ADDITIONAL SPECIMEN EXAMINED: *Xylaria chordaeformis* Lloyd, Brazil, Bahia, C. Torrend, Cat. # 10382 (BPI: TYPE).

NOTES: The gross morphology of *Xylaria tumulosa* is much like the type of *X. chordaeformis*. The Mexican collection differs from *X. chordaeformis* in its smaller ascospores, i.e. (16.5-) 17-20 (-22) x (6-) 7-8 μm vs (20-) 22-26.5 x (5-) 5.5-7 μm , and the straight ascospore germ slits instead sigmoid to spiral ones [see also description of *X. luxurians* (Rehm) Lloyd in Dennis, 1956 and San Martín, 1992].

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NOTES ON HYPHOMYCETES. LXXXIV. PSEUDOTRICHOCONIS AND RHEXODENTICULA, TWO NEW MONOTYPIC GENERA WITH RHEXOLYTICALLY DISARTICULATING CONIDIAL SEPARATING CELLS

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ABSTRACT

Two new genera, *Pseudotrichoconis* and *Rhexodenticula*, are established for the anamorphs previously classified as *Trichoconis echinophila* and *Nakataea cylindrospora*, respectively. Both are redescribed and illustrated, the latter from a recent collection made in Alabama. Generic concepts are discussed with particular reference to peculiarities of denticulate conidiophores and the precise nature of conidial detachment. Comparison is made between these taxa and morphologically similar entities.

KEYWORDS: *Dactylaria*, *Nakataea*, *Ochroconis*, *Scolecobasidium*, generic concepts.

INTRODUCTION

An unusual dematiaceous anamorph having rhexolytically disarticulating conidial separating cells, collected recently on dead leaves of water oak (*Quercus nigra* L.) in Chewacla State Park, Alabama, has been identified as *Nakataea cylindrospora* Castañeda, Saikawa & Hennebert, although it differs slightly in degree of conidium pigmentation from the type description of that taxon (Castañeda *et al.*, 1996). In the process of determining its identity some question has arisen as to appropriate generic circumscription and placement. In particular, the suitability of *Nakataea* Hara, as typified by *N. sigmoidea* (Cav.) Hara, the anamorph of *Leptosphaeria*

salvinii Catt., for *N. cylindrospora* and somewhat similar entities has had to be considered. This genus is characterized by possession of distinctly sigmoid conidia and its type species is the causal organism of a serious stem rot disease of rice (*Oryza sativa* L.). Since its inception, five additional species, namely *N. curvularioides* G. Arnold, *N. cylindrospora*, *N. fusispora* (Matsushima) Matsushima, *N. rarissima* Castañeda & Kendrick, and *N. serpens* Shearer & Crane, have been added to *Nakataea*, but some reasonable doubt can be raised concerning the appropriateness of the current classification of several of these. Interestingly, in the description of *N. rarissima* (Castañeda and Kendrick, 1990), no mention is made of the presence of a separating cell and the conidia, which are straight and narrowly obclavate in shape, sometimes produce a secondary, downwardly-growing conidium arising singly at an obtuse angle proximal to their denticulate base. It seems unlikely that this taxon properly belongs in *Nakataea*. In the case of *N. cylindrospora* also, as the specific epithet indicates, the conidia are differently shaped from those typical of the genus and, moreover, are verruculose. As in *N. rarissima*, the existence of a separating cell is not mentioned in the original description of *N. cylindrospora* (Castañeda *et al.*, loc. cit.), although it is apparent that one is present. All things being considered, including the above-mentioned features and certain others, it seems necessary to accommodate this species elsewhere. Accordingly, a new generic name is established for it herein and it is redescribed and illustrated. Further consideration of the status of *N. rarissima* must await critical examination of its type.

During the course of reviewing alternative classification options for *N. cylindrospora*, a somewhat similar anamorph, currently known as *Trichoconis echinophila* (Massal.) de Hoog & van Oorschot, came to our attention. This taxon, which has previously been variously classified in both *Dactylaria* Sacc. and *Scolecobasidium*. E.V. Abbott, was placed in *Trichoconis* Clem. because its rhexolytic method of conidial secession was said to strongly suggest a relationship with the latter genus (de Hoog and van Oorschot, 1985). This entity, however, unlike species of *Trichoconis* which typically overgrow other fungi biotrophic on leaves in the tropics, particularly members of the orders Dothidiales and Meliolales, is known mainly from decayed cupular spines of species of *Castanea* Mill. in Europe. In addition to the ecological niche which it occupies *T. echinophila* has certain other peculiarities which lead us to believe that it remains unsatisfactorily classified. An additional novel genus is therefore proposed in which to accommodate it.

TAXONOMIC PART

Rhexodenticula W.A. Baker et Morgan-Jones gen. nov.

Coloniae effusae, pilosae, brunneae. Mycelium partim in substrato immersum et partim superficiale, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus compositum. Conidiophora macronemata, mononemata, singula vel caespitosa, simplicia, erecta, cylindrica, recta vel flexuosa, sympodialia, septata, laevia, brunnea, apicem versus pallidiora, ex cellulis globosis, atrobrunneis oriunda. Cellulae conidiogenae in conidiophoris incorporatae, terminales vel raro intercalares, polyblasticae, denticulatae. Cellula separans frangens, pars in conidiophoro persistens. Conidia solitaria, sicca, acropleurogena, cylindrica, septata, verruculosa, pallide brunnea, cellula media fuscata, ad apicem obtusa, ad basim fimbriata. Species typica *Rhexodenticula cylindrospora* (R.F. Castañeda, Saikawa & Hennebert) W.A. Baker & Morgan-Jones

Rhexodenticula W.A. Baker & Morgan-Jones gen. nov.

Colonies effuse, hairy, brown. Mycelium partly immersed in the substrate, partly superficial, composed of branched, septate, pale brown to brown, smooth hyphae. Conidiophores macronematous, mononematous, solitary or caespitose, simple, erect, cylindrical, straight or somewhat flexuous, sympodial, septate, smooth, brown, paler toward the apex, arising from a small cluster of dark-brown, globose cells. Conidiogenous cells integrated, terminal or rarely intercalary, polyblastic, denticulate. Separating cell fracturing and remaining as a persistent peg-like extension. Conidia solitary, dry, acropleurogenous, cylindrical, septate, verruculose, pale brown, middle cells slightly darker, obtuse at the apex, with a narrow basal marginal frill.

Etymology: Gr. *rhexi*, a break, rupture; et L. *denticulatus*, denticulate.

Rhexodenticula cylindrospora (R.F. Castañeda, Saikawa & Hennebert) W.A. Baker & Morgan-Jones comb. nov. (Figure 1).

≡ *Nakataea cylindrospora* R.F. Castañeda, Saikawa & Hennebert, *Mycotaxon* 59: 457, 1996.

Colonies effuse but mostly limited to the costal regions of the decaying leaf, hypophyllous, hairy, olivaceous brown to dark brown or eventually blackish, generally somewhat thin. Mycelium partly immersed in the substrate, partly superficial, composed of branched, septate, pale brown to

brown, smooth, 1-2 μ m hyphae. Conidiophores macronematous, mononematous, solitary or gregarious in caespitose clusters of two or three, simple, erect, cylindrical, occasionally with a nodose swelling toward the middle, straight or somewhat flexuous, sympodial, with the distal portion sometimes becoming very slightly geniculate, septate, smooth, brown, somewhat paler toward the extreme apex, up to 110 μ m long, 3.5-5.5 μ m wide, moderately bulbous and 8-11 μ m wide at the base, arising from a small cluster of tightly-packed, more or less globose, 8-14 μ m wide cells. Conidiogenous cells integrated, terminal, or rarely with the intercalary, immediately subterminal cell bearing one or two conidiogenous loci, polyblastic, denticulate; each denticle cylindrical, 1-2 μ m long, comparatively thin-walled, and cut off by a septum to form a separating cell which fractures at its middle in a circumsissile fashion and remains as a persistent, peg-like extension. Conidia solitary, dry, acropleurogenous, cylindrical, three-septate, rarely one- or two-septate, with the septa more or less evenly placed, verruculose, pale brown, with the two middle cells very slightly darker, obtuse at the apex, bearing a narrow, basal, vestigial, marginal frill derived from the upper portion of the rhexolytically split separating cell, 13-21 $\times$ 4-5 μ m in size.

On decaying leaves of *Nectandra antillana* C.F.W. Meissn., and *Quercus nigra* L.; Cuba and North America.

Collection examined: on *Q. nigra*, Chewacla State Park, Lee Co., Alabama, U.S.A., 13 September 2000, W.A. Baker, AUA.

In all essential characteristics the Alabama specimen of this species matches the type description. However, judging from the original account of its characteristics, some small differences apparently exist between it and the type material collected in Cuba. These include having narrower, more slender conidiophores, which generally bear fewer conidiogenous loci, arising from globose cells which are appreciably smaller than those present in the Cuban material. The conidial dimensions and coloration of the respective specimens also differ somewhat. The extent of the contrast between the two central cells and the end cells, in terms of degree of pigmentation, is less pronounced in the collection reported upon herein. In the type description the central cells are described as being brown and the end cells subhyaline or pale brown whereas in our material the conidia are almost uniformly pale brown with the central cells becoming only barely darker upon maturation. We have little doubt, however, that the Alabama material represents the second collection ever made of this anamorph.

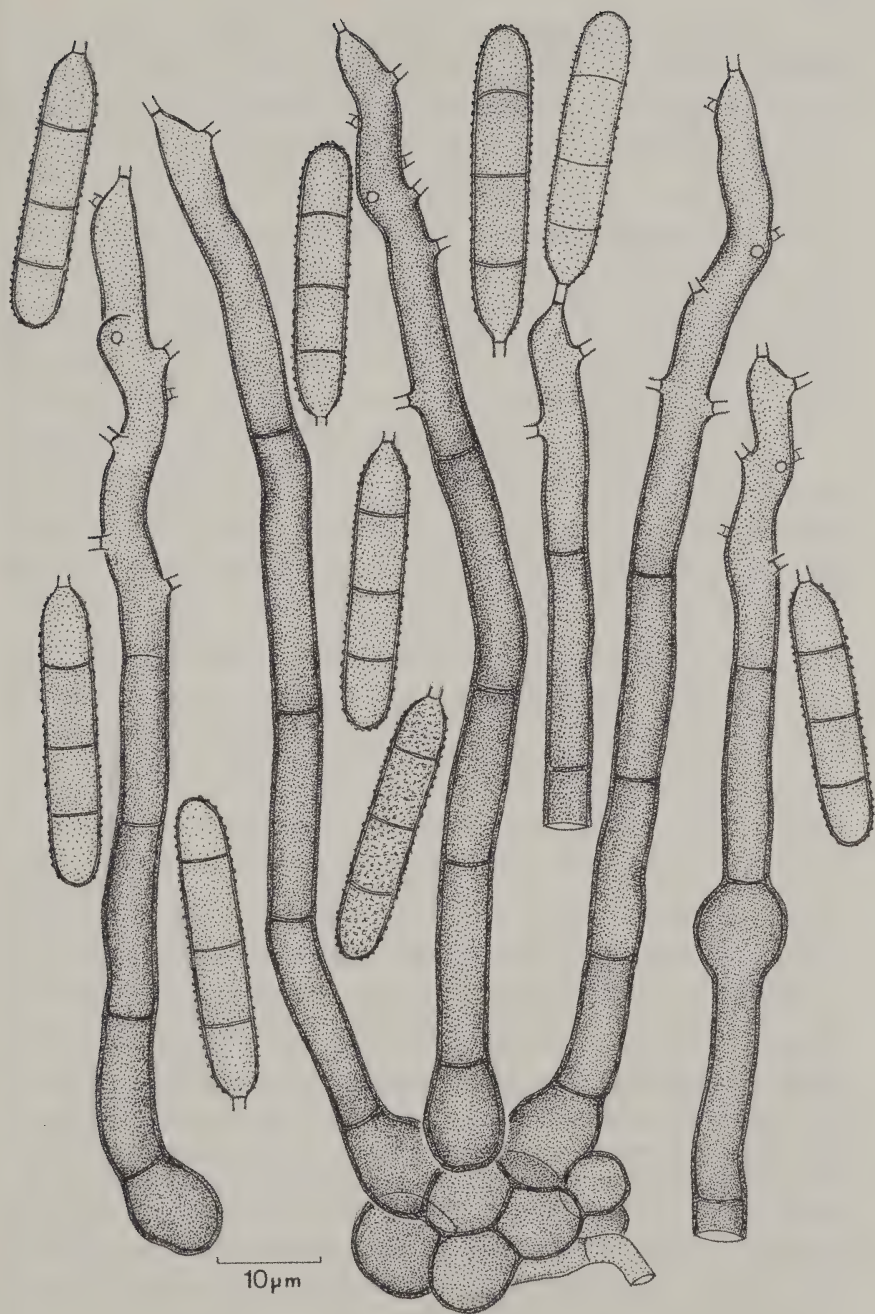


FIGURE 1. *Rhexodenticula cylindrospora*. Conidiophores and conidia.

A number of unrelated Hyphomycete genera, including such entities as *Brachysporium* Sacc., *Camposporium* Harkness, *Nakataea*, *Pyricularia* Sacc., and *Trichoconis*, all share the common feature of having conidial separating cells. In reaching the decision to establish a new genus in which to accommodate *N. cylindrospora* consideration has been given to a number of significant differences between it and *N. sigmoidea*, the type species. These are of a comparable dimension to those which separate *Nakataea* from *Pyricularia*. Although broadly similar in morphology, the conidiophores of *N. sigmoidea* have a different look in being somewhat more flexuous and in having widely scattered conidiogenous loci along a greater length, including a number in intercalary positions, usually on several subtending conidiophore cells. Moreover, each conidiophore bears comparatively few such loci, as compared to the condition seen in *N. cylindrospora*, where loci are numerous, crowded, and located mostly on the terminal cell. Added to this is the considerable difference in the shape of the conidia and, in the case of *N. sigmoidea*, lack of any surface ornamentation. The plant-pathogenic nature of *N. sigmoidea* and the fact that it produces moderately-sized sclerotia are additional points of distinction.

As alluded to above, it is of some interest that the presence of separating cells were not mentioned in several type descriptions of *Nakataea* species. These are, admittedly, not always easily discernible. In particular, the narrow septum which delimits the separating cell from the remainder of the conidiophore is often difficult to observe, especially when it is displaced laterally. Where terminal at the extreme conidiogenous cell apex, with the conidium remaining attached, this septum is much more readily apparent.

Matsushima (1975) named and described *Scolecobasidium longiphorum* Matsushima, an anamorph isolated from insect frass on dead leaves of *Quercus* sp. in Japan which appears to be close, if not identical to, *N. cylindrospora*. Since the type description was based on the morphological expression extant in axenic *in vitro* culture it is difficult, however, to determine if this is indeed the same fungus. The conidial shape, pigmentation, although with all cells evenly-colored, septation, surface ornamentation, and size are comparable. Moreover, the conidia are similarly fimbriate at the base and from the illustration provided there is indication of the presence of a separating cell, although this is not mentioned in the species diagnosis. The conidiophores, in contrast to those of *N. cylindrospora*, are extremely long and narrow with conidiogenous loci spread along almost their entire length and occurring on numerous intercalary cells. It is uncertain if these conidiophore characteristics are merely a cultural, phenotypic expression. The identity of this taxon must, for the time being at least, remain in doubt. Since

it appears to have conidial separating cells, it clearly does not belong in *Scolecobasidium* nor, for that matter, in the segregate genus *Ochroconis* De Hoog & Arx. Whether or not it is the same anamorph as that described herein or is, perhaps, a second species of *Rhexodenticula* must await further consideration.

Pseudotrichoconis W.A. Baker et Morgan-Jones gen. nov.

Coloniae effusae, densae, pulveraceae, albae vel roseae. Mycelium plerumque superficiale vel partim immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, laevibus compositum. Hyphae capitatae, erectae, septatae, praeditum, ex lateribus et terminalibus hypharum oriunda. Conidiophora macronemata, mononemata, singula, simplicia, erecta, cylindrica, ad apicem attenuata, recta vel flexuosa, sympodiala, septata, laevia, parietibus tenuibus, subhyalina vel pallide brunnea. Cellulae conidiogenae in conidiophoris incorporatae, terminales vel intercalares, polyblasticae, denticulatae. Cellula separans fragens, pars in conidiophoro persistens. Conidia solitaria, sicca, acropleurogena, cylindrica, septata, verruculosa, subhyalina, ad apicem obtusa, ad basim attenuata, fimbriata. Species typica *Pseudotrichoconis echinophila* (C. Massal.) W.A. Baker & Morgan-Jones

Pseudotrichoconis W.A. Baker & Morgan-Jones gen. nov.

Colonies effuse, dense, powdery, white to pinkish-white. Mycelium mostly superficial, often partly immersed, composed of branched, septate, hyaline to pale brown, smooth hyphae. Prostrate hyphae occasionally interweaving and somewhat rope-like. Sterile capitate hyphae present, originating laterally or terminally from repent hyphae, ascending, erect, more or less straight, septate, cylindrical, clavate, subglobose, or ellipsoid at the apex. Conidiophores macronematous, mononematous, single, occasionally arising in close proximity to one another and loosely intertwined, simple, erect, cylindrical, attenuated slightly toward the apex, erect, straight to slightly flexuous, sympodial, septate, smooth, thin-walled, subhyaline to pale brown. Conidiogenous cells integrated, terminal or intercalary, polyblastic, denticulate. Separating cell fracturing and remaining as a persistent peg-like extension. Conidia solitary, dry, acropleurogenous, cylindrical to narrowly clavate, septate, minutely verruculose, subhyaline to very pale brown when mature, obtuse at the apex, attenuated at the base with a narrow marginal frill.

Etymology: Gr. *pseudo*, false; et *Trichoconis*.

Pseudotrigoconis echinophila (C. Massal.) W.A. Baker & Morgan-Jones comb. nov. (Figure 2).

≡ *Dactylaria echinophila* C. Massal., *Atti R. Ist. Ven. Sci., Lett., Arti* 59:685, 1900.

≡ *Scolecobasidium echinophilum* (C. Massal.) B. Sutton, *Trans. Brit. myco. Soc.* 61:424, 1973.

≡ *Trigoconis echinophila* (C. Massal.) de Hoog & Oorschot, *Stud. Mycol.* 26:107, 1985.

Colonies effuse, spreading widely over the substrate, generally somewhat dense, powdery, white to pinkish-white. Mycelium mostly superficial or, less often, partly immersed in the substratum, composed of irregularly branched, septate, hyaline to subhyaline to pale brown, smooth, cylindrical, 2.5-4µm wide hyphae. Prostrate hyphae occasionally interweaving and somewhat rope-like. Sterile capitate hyphae present originating laterally or terminally from repent hyphae, ascending, erect, more or less straight, septate, cylindrical, clavate, subglobose, or ellipsoid at the apex, sometimes slightly bulbous at the base, up to 50µm long, 3-4.5µm wide at the inflated, clavate, subglobose, or ellipsoid apex. Conidiophores macronematous, mononematous, single, occasionally arising in close proximity to one another and loosely intertwined, sometimes alternating with capitate hyphae as lateral extensions of the prostrate hyphae, simple, erect, cylindrical, attenuated slightly toward the apex, straight to slightly flexuous, sympodial, septate, smooth, thin-walled, subhyaline to pale brown, up to 60µm long, 3.5-5µm wide, up to 6µm wide at the base. Conidiogenous cells integrated, terminal or intercalary, polyblastic, denticulate; each denticle cylindrical, thin-walled, and cut off by a septum to form a separating cell which fractures at its middle in a circumscissile fashion and remains as a persistent, peg-like extension. Conidia solitary, dry, acropleurogenous, cylindrical to narrowly clavate, septate, minutely verruculose, subhyaline to very pale brown, obtuse at the apex, attenuated at the base with a narrow marginal frill derived from the upper portion of the rhexolytically split separating cell, 9-32 × 3.5-5µm in size.

On decaying seeds, cupules, and cupular spines of *Castanea sativa* Mill. and twigs of *Quercus robur* L.; Europe.

Collections examined: on *C. sativa*, Esher Common, Surrey, U.K., 17 September 1972, B.C. Sutton (IMI 168988); on *C. sativa*, Oxshott Heath,

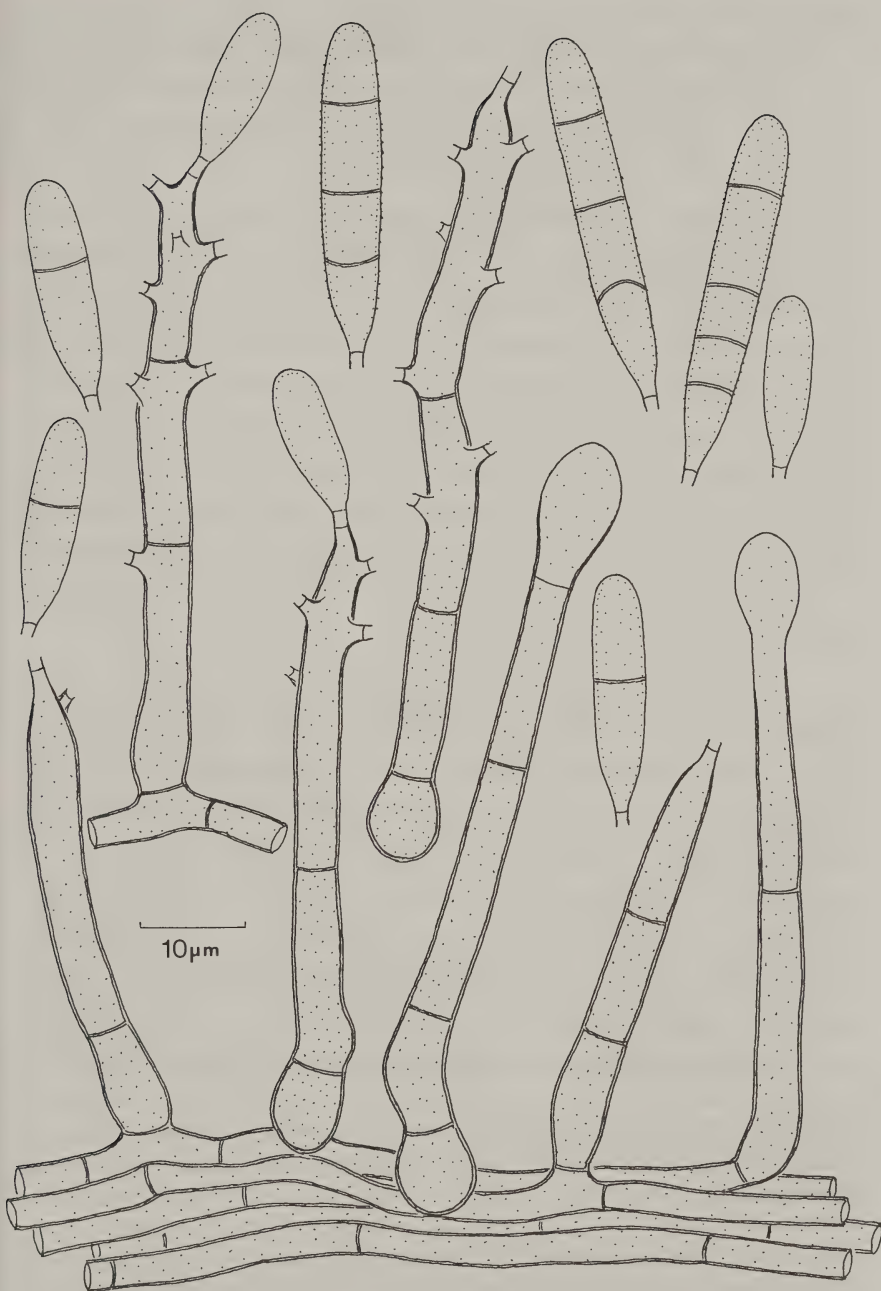


FIGURE 2. *Pseudotrigoconis echinophila*. Conidiophores and conidia.

Surrey, U.K., 8 October, 1972, B.C. Sutton (IMI 169715); on *C. sativa*, Underriver, Kent, U.K., 20 November 1972, B.C. Sutton (IMI 170818); on *C. sativa*, Maresfield, Ashdown Forest, Sussex, U.K., 20 November 1972, B.C. Sutton (IMI 170859); on *C. sativa*, Wimbledon Common, London, U.K., 3 December 1972, B.C. Sutton (IMI 171186).

A number of factors have, apparently, contributed to some misunderstanding about the true identity and distinctiveness of this anamorph. Von Arx (1970) illustrated what appears to be this species under the name *Dactylaria purpurella* (Sacc.) Sacc. and some confusion between the two evidently continued (Matsushima, 1975; 1983) for some time thereafter. Perhaps the ambivalence existing in the literature concerning the *Dactylaria* Sacc. generic concept and lack of adequate documentation of the essential characteristics of its type species, *D. purpurella*, was, in part at least, responsible for this. As Bhatt and Kendrick (1968) noted, the understanding of *Dactylaria* depended upon interpretation of the inadequate holotype material of *D. purpurella* [$\equiv$ *Acrothecium purpurella* Sacc.]. Sutton (1973) provided what can be considered the first definitive account of *Dactylaria echinophila* based on a number of collections made by him in England [see above].

This taxon had originally been described from material occurring on *Castanea sativa* [as *Castanea vesca* Gaertn.] in Italy (Massalongo, 1900). Although the type material appears to be lost, since none is extant in the herbarium at Istituto Orto Botanico dell'Università, Padova [PAD], the original description provided was considered by Sutton (loc. cit.) to be sufficiently adequate for purposes of establishing the identity of his specimens. In spite of being brief, Massalongo's account of this entity included mention of such hallmark features as the white, powdery colonies, the presence of repent, sterile, interwoven hyphae, and possession of simple, septate conidiophores and cylindrical-fusoid, hyaline conidia formed from denticles. The dimensions of these structures noted in the type description more or less matched those in the English collections. In the absence of a type specimen, Sutton (loc. cit.) expressed the view that the name *Dactylaria echinophila* should, ideally, be neotypified by collection of material from the same substrate and locality but this has not, to our knowledge, been accomplished.

In the process of determining whether or not this anamorph was satisfactorily classified in *Dactylaria*, Sutton (loc. cit.) examined a type slide of *D. purpurella* and concluded that conidia of that species possess a basal scar but no frill. Bhatt and Kendrick (loc. cit.) had earlier made a similar

observation, following examination of the same slide, that the conidia taper toward a narrow flat basal scar and that the conidiophores bear conspicuous, flat-topped denticles clustered closely in the apical region. Photographic illustration by the latter authors clearly indicate these characteristics. Interestingly, Saccardo's original illustration (Saccardo, 1877) shows the same features. Based on the concept of *Dactylaria* clarified by Bhatt and Kendrick (loc. cit.), Sutton (loc. cit.) reached the decision that *D. echinophila* could not be included in that genus and, accordingly, transferred this species to *Scolecobasidium*. In so doing, particular attention was paid to the fact that conidia of the latter genus are detached by a break in the wall of the denticles upon which they are born, leaving a part attached to the conidium as a basal frill and part to the conidiogenous cell (Barron and Busch, 1962; Ellis, 1971). The determination that *D. echinophila* was better placed in *Scolecobasidium* was, however, qualified with an opinion to the effect that it might be necessary in the future to classify it into a separate genus because of the presence of sterile capitate hyphae, lack of pigmentation and the wide variation in conidial shape and ornamentation among species of *Scolecobasidium* as circumscribed by Ellis (loc. cit.).

This anamorph cannot, however, be satisfactorily classified in *Scolecobasidium* because of the absence of a conidial separating cell in that genus. The disparity in conidium shape within it was recognized by de Hoog and von Arx (1973), who established the segregate genus *Ochroconis* for those species with ellipsoid, clavate, or fusiform conidia, while use of the older generic name was restricted to species with trilobate conidia. Although some species of *Ochroconis* are broadly similar to *Pseudotrichoconis echinophila* they all differ by lacking conidial separating cells. It should be added, incidentally, that some doubt must be raised as to the homogeneity of *Ochroconis* as originally conceived since the conidia of its type species, *O. constricta* (Abbott) de Hoog & Arx, bear a basal frill, indicating rhexolytic detachment, whereas other species accommodated within it lack such a feature, which may indicate a *Dactylaria*-like schizolytic mode of detachment. In light of this, a review of the genus is surely needed.

Matsushima (1975) described and illustrated what appears to be *Pseudotrichoconis echinophila* [as *Dactylaria echinophila*], based on a collection made on decaying bark of *Acer* sp. in Japan. No capitate hyphae were observed, however. He was, presumably, unaware of Sutton's contribution to our knowledge of this anamorph. Curiously, both Sutton (loc. cit.) and Matsushima (1975) illustrate the conidiophore-borne denticles as separating cells (a septum is shown delimiting the denticle remnant from the conidiophore venter following conidial secession) but make no mention of

such in their respective descriptions of this entity. Matsushima (1983) continued to use the name *Dactylaria echinophila* and applied it to three further collections isolated from diverse substrates and localities (rotten cacao fruits, Ponape; dead leaves of *Taxus canadensis* Marsh., and basidiocarp of *Ganoderma tsugae* Murrill, Canada). From his description and illustrations it seems unlikely, however, that these were correctly identified. In each case, conidiophore denticles are shown with the closed, flat-topped extremity typical of *Dactylaria*. In a note following the species description the author stated that it is close to *D. purpurella* and added that a difficulty lies in the presence of what were referred to as intermediate strains between these two entities. It is evident that these two taxa were being confused and that the collections reported in Matsushima's 1983 publication were not *P. echinophila* but rather *D. purpurella*. The smooth conidium walls and the absence of a separating cell, as evidenced by lack of a basal frill on the conidia, should have indicated the true identity of the Ponape and Canada collections.

De Hoog and van Oorschot (loc. cit.) briefly described and illustrated *P. echinophila* in their check-list of epithets in the *Dactylaria* and *Arthrobotrys* Corda complexes. Specimens examined included *in vivo* and *in vitro* material from *Quercus robur* L. twig and *Picea* A. Dietr. needle [both without collection origin details] and a collection on *Castanea sativa* nut housed at IMI [without collection particulars, but not one cited by Sutton]. The authors noted that conidium secession in this species is clearly rhexolytic and this, as alluded to in the introduction above, led to a decision to reclassify it in *Trichoconis*. In their protolog it is mentioned that the illustration purported to be of *D. purpurella* published by von Arx (loc. cit.), and that of *D. purpurella* published by Ellis (loc. cit.), fit that given by Matsushima (1983) for *D. echinophila*. The present authors agree with this opinion, again indicating that Matsushima had *D. purpurella* and not *D. echinophila*, unlike the situation previously (Matsushima, 1975) where he apparently had the latter. It should be added that the von Arx illustration, which is believed to be of *D. echinophila* rather than *D. purpurella*, failed to depict the true nature of the denticles.

The rationale for reclassifying *D. echinophila* in *Trichoconis* (de Hoog and van Oorschot, loc. cit.) can be understood but it is highly doubtful that this entity belongs in that genus. Although sharing the common characteristic of having conidial separating cells there are some significant differences that should be considered. The conidia of the type and other species of *Trichoconis* are fusiform to obclavate in shape and smooth-walled. Moreover, the separating cells of most species are long cylindric and the conidia entirely

hyaline. An additional difference is the presence of sterile, capitate hyphae in *P. echinophila*, a feature not noted by de Hoog and van Oorschot (loc. cit.). As mentioned by Sutton (loc. cit.) possession of such structures has traditionally been considered to be of some taxonomic significance, as is the case, for example, in typifying such Hyphomycete genera as *Cylindrocladiella* Boesew. and *Cylindrocladium* Morgan. The fact that almost all true species of *Trichoconis* occur as follicolous hyperparasites on such Ascomycete genera as *Asterina* Lév., *Balladyna* Racib., *Irenopsis* F. Stevens, *Meliola* Fr., and *Schiffnerula* Höhn., is an additional point of distinction. The type species, *T. caudata* (Appel & Strunk) Clements, is an exception, overgrowing as it does *Lasiodiplodia theobromae* (Pat.) Griff. & Maubl. on diseased pods of *Theobroma cacao* L. For all these reasons, there can be little doubt that *P. echinophila* needs to be segregated in a genus of its own.

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A LIST OF DISCOMYCETES IN CHINA. SUPPLEMENT I *

(中国盘菌名录, 续一)

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Abstract: This is the continuation of "A list of discomycetes in China" published in 1998. Cup-fungi recorded from China afterwards are added. Corrections and errata for names in the previous list are provided.

Key words: Addition, name change, errata.

This is a supplementary list to the previous records of Chinese discomycetes (Zhuang, 1998a). Scientific name, Chinese name, and the related reference(s) are provided for each newly added taxon. Changes for several names in the previous list are made according to current taxonomic treatments. Mistakes in spellings are corrected in errata.

SUPPLEMENTARY LIST — I

Acervus cf. *flavidus* (Berk. & M.A. Curtis in Berk.) Pfister (参照) 黄小孢盘菌 (Zhuang & Wang 1998)

Acervus xishuangbannicus W.Y. Zhuang & Z. Wang 版纳小孢盘菌 (Zhuang & Wang 1998)

Albotricha cf. *albotestacea* (Desm.) Raitv. (参照) 白壳白毛盘菌 (Zhuang 1998b)

Albotricha changbaiensis W.Y. Zhuang & Z.H. Yu 长白白毛盘菌 (Yu *et al.* 2000)

Albotricha guangxiensis W.Y. Zhuang 广西白毛盘菌 (Zhuang 1998b)

Albotricha kurilensis Raitv. 库页白毛盘菌 (Zhuang 2000b)

Albotricha minuta Raitv. 小白毛盘菌 (Yu *et al.* 2000)

Arachnopeziza aurata Fuckel 金蛛盘菌 (Zhuang 1998b)

Ascobolus amoenus Oudem. 喜粪盘菌 (Wang 1999)

Ascobolus fushanus Y.Z. Wang 福山粪盘菌 (Wang & Brummelen 1997)

Aurophora dochmia (Berk. & M.A. Curtis) Rifai 耳盘菌 (Zhuang & Wang 1998)

Bifusella camelliae C. L. Hou 茶小双梭孢盘菌 (Hou, 1999)

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- Cheilymenia elaphorum* (Rehm) W.Y. Zhuang & Z. Wang 鹿缘刺盘菌 (Zhuang & Wang 1998)
- Cistella geelmuydenii* Nannf. 吉氏小毛盘菌 (Yu *et al.* 2000)
- Coccomyces circinatus* Y.R. Lin & C.T. Xiang 卷丝齿裂菌 (Lin *et al.* 2000)
- Coccomyces crateriformis* Y.R. Lin & Z.Z. Li 杯状齿裂菌 (Lin *et al.* 2000)
- Coccomyces cyclobalanopsis* R.R. Lin & Z.Z. Li 青冈齿裂菌 (Lin *et al.* 2000a)
- Coccomyces dimorphus* X.W. Liang, X.Y. Tang & Y.R. Lin 异囊齿裂菌 (Liang *et al.* 2000)
- Coccomyces fujianensis* R.R. Lin & C.T. Xiang 福建齿裂菌 (Lin *et al.* 2000a)
- Coccomyces huangshanensis* Y.R. Lin & Z.Z. Li 黄山齿裂菌 (Lin *et al.* 2000b)
- Coccomyces leptideus* (Fr. : Fr.) Erikss. 小齿裂菌 (Lin *et al.* 2000b)
- Coccomyces limitatus* (Berk. & M.A. Curtis) Sacc. 显缘齿裂菌 (Lin *et al.* 2000b)
- Coccomyces magnus* Y.R. Lin & Z.Z. Li 大齿裂菌 (Lin *et al.* 2000b)
- Coccomyces multangularis* Y.R. Lin & Z.Z. Li 多角齿裂菌 (Lin *et al.* 2001)
- Coccomyces radiatus* Sherw. 辐射状齿裂菌 (Lin *et al.* 2001)
- Coccomyces sinensis* Y.R. Lin & Z.Z. Li 中国齿裂菌 (Lin *et al.* 2001)
- Coccomyces symploci* Y.R. Lin & Z.Z. Li 山矾齿裂菌 (Lin *et al.* 2001)
- Coprotus lacteus* (Cooke & W. Phillips) Kimbr., Luck-Allen & Cain 乳粪裸盘菌 (Zhuang & Wang 1998)
- Dasyscyphella dryina* (P. Karst.) Raitv. 榲小毛钉菌 (Yu *et al.* 2000)
- Diccephalospora damingshanica* W.Y. Zhuang 大明山二头孢盘菌 (Zhuang 1999b)
- Diccephalospora pinglongshanica* W.Y. Zhuang 平龙山二头孢盘菌 (Zhuang 1999b)
- Encoelia dalongshanica* W.Y. Zhuang 大龙山散孢盘菌 (Zhuang 1999a)
- Encoelia taxonomic* sp. (Zhuang 1999a)
- Hamatocanthoscypha unipila* Huhtinen 钩毛钩刺盘菌属 (Yu *et al.* 2000)
- Holwaya mucida* (Schulzer) Korf & Abawi subsp. *nipponica* Korf & Abawi 霉霍氏盘菌日本亚种 (Yu *et al.* 2000)
- Hydnотrya cubispora* (E.A. Bessey & B.E. Thompson) Gilkey 方孢腔块菌 (Xu 2000b)
- Hymenoscyphus lutescens* (Hedw.: Fr.) W. Phillips 土黄膜盘菌 (Yu *et al.* 2000)
- Hymenoscyphus taxonomic* sp. #1 (Yu *et al.* 2000)
- Hymenoscyphus taxonomic* sp. #2 (Yu *et al.* 2000)
- Lachnum albidulum* (Penz. & Sacc.) M.P. Sharma 白毛粒毛盘菌 (Wu 1998)
- Lachnum* cf. *apalum* var. *beatonii* Spooner (参照) 软粒毛盘菌毕氏变种 (Zhuang 1998b)
- Lachnum* cf. *brevipilosum* Baral & Krieglst. 短毛粒毛盘菌 (Baral & Krieglsteiner 1985; Zhuang & Wang 1998 as *Lachnum legalii*, superfluous)
- Lachnum carneolum* (Sacc.) Rehm 肉色粒毛盘菌 (Zhuang & Hyde 2001b)
- Lachnum cylindricum* W.Y. Zhuang & K.D. Hyde 柱孢粒毛盘菌 (Zhuang & Hyde 2001b)
- Lachnum granulatum* W.Y. Zhuang, Yanna & K.D. Hyde 粒丝粒毛盘菌 (Zhuang & Hyde 2001b)

- Lachnum cf. euterpes* Cantrell & J.H. Haines (参照) 棕榈粒毛盘菌 (Zhuang & Wang 1998)
- Lachnum lunatum* W.Y. Zhuang & Spooner 新月粒毛盘菌 (Zhuang 2000b)
- Lachnum cf. nudipes* (Fuckel) Sacc. var. *minor* Spooner (参照) 裸粒毛盘菌小变型 (HMAS specimen)
- Lachnum oncospermatum* (Berk. & Broome) M.L. Wu & J.H. Haines 瘤状粒毛盘菌 (Wu *et al.* 1998)
- Lachnum palmae* (Kanouse) Spooner 棕榈生粒毛盘菌 (Fröhlich 1997)
- Lachnum cf. pteridophyllum* (Rodway) Spooner 蕨粒毛盘菌 (Wu *et al.* 1998, Zhuang & Wang 1998)
- Lachnum cf. salicariae* (Rehm) Raitv. (参照) 千曲菜粒毛盘菌 (Yu *et al.* 2000)
- Lachnum subpygmaem* W.Y. Zhuang 亚根粒毛盘菌 (Zhuang 1998b)
- Lachnum taiwanense* J.H. Haines, M.L. Wu & Y.Z. Wang 台湾粒毛盘菌 (Wu *et al.* 1998)
- Lachnum willisii* (G.W. Beaton) Spooner 威氏粒毛盘菌 (Zhuang 1998b)
- Lachnum taxonomic* sp. #1 (Zhuang 1998b)
- Lachnum taxonomic* sp. #2 (Zhuang 1998b)
- Lambertella caudatoides* W.Y. Zhuang 尾孢兰伯盘菌 (Zhuang 1999b)
- Lanzia guangxiensis* W.Y. Zhuang 广西兰斯盘菌 (Zhuang 1999a)
- Lanzia sinensis* W.Y. Zhuang 中国兰斯盘菌 (Zhuang 1999a)
- Lasiobelonium guangxiense* W.Y. Zhuang 广西针毛盘菌 (Zhuang 1998b)
- Lasiobelonium ningxiaense* W.Y. Zhuang & Spooner 宁夏毛盘菌 (Zhuang 2000b)
- Lophodermium dicranopteris* Y.R. Lin, Y.H. Liu & Z. Li 芒萁散斑壳 (Liu *et al.* 1995)
- Microglossum viride* (Pers.: Fr.) Gill. 绿小舌菌 (HMAS specimen)
- Neococcomyces* R.Y. Lin, C.T. Xiang & Z.Z. Li 新齿裂菌属 (Lin *et al.* 1999)
- Neococcomyces rhododendri* R.Y. Lin, C.T. Xiang & Z.Z. Li 新齿裂菌 (Lin *et al.* 1999)
- Octospora yunnanica* W.Y. Zhuang & Z. Wang 云南八孢盘菌 (Zhuang & Wang 1998)
- Orbilia delicatula* (P. Karst.) P. Karst. 迷人圆盘菌 (Wu 1998)
- Orbilia sarraziniana* Henn. 萨拉圆盘菌 (Zhuang & Hyde 2001a)
- Pachyella babingtonii* (Berk. & Broome) Boud. 巴氏厚盘菌 (Zhuang & Wang 1998)
- Parachnopeziza bambusae* Arendholz & R. Sharma 竹近蛛盘菌 (Zhuang 1999a)
- Parachnopeziza guangxiensis* W.Y. Zhuang & Korf 广西近蛛盘菌 (Zhuang 1998b)
- Parachnopeziza variabilis* W.Y. Zhuang & K.D. Hyde 变异近蛛盘菌 (Zhuang & Hyde 2001a)
- Parachnopeziza sinensis* W.Y. Zhuang & Korf 中国近蛛盘菌 (Zhuang 1998b)
- Perrotia hongkongensis* W.Y. Zhuang & K.D. Hyde 香港钝囊盘菌 (Zhuang & Hyde 2001b)
- Perrotia nanjenshana* Y.Z. Wang & J.H. Haines 南靖山钝囊盘菌 (Wang & Haines 1999)

- Perrotia pilifera* W.Y. Zhuang & Z.H. Yu 毛丝钝囊盘菌 (Zhuang & Yu 2001)
- Perrotia yunnanensis* W.Y. Zhuang & Z.H. Yu 云南钝囊盘菌 (Zhuang & Yu 2001)
- Pezicula cinnamomea* (DC.) Sacc. 樟无柄盘菌 (Zhuang 1999a)
- Pezicula cf. rubi* (Libert) Niessl (参照) 悬钩子无柄盘菌 (Zhuang & Wang 1998)
- Peziza guizhouensis* M.H. Liu 贵州盘菌 (Liu 1998)
- Peziza shearii* (Gilkey) Korf 希氏盘菌 (Liu 1998)
- Peziza* sp. (Zhuang & Hyde 2001a)
- Peziza urinophila* Y.Z. Wang & Sagara 嗜尿盘菌 (Wang & Sagara 1997)
- Pezoloma ciliifera* (P. Karst.) Korf 毛缘胶鞘盘菌 (HMAS specimen)
- Phaeohelotium cf. subcarneum* (Schumach. ex Sacc.) Dennis (参照) 亚肉色暗柔膜菌 (Zhuang & Wang 1998)
- Phillipsia hartmannii* (W. Phillips) Rifai 哈特曼歪盘菌 (Zhuang & Wang 1998)
- Phillipsia umbilicata* (Penz. & Sacc.) Boedijn 脐状歪盘菌 (Zhuang & Wang 1998)
- Phialina damingshanica* W.Y. Zhuang 大明山隔毛小杯菌 (Zhuang 1999a)
- Pithyella cf. erythrostigma* (Berk. & Broome) Boud. (参照) 红点微艳盘菌 (Zhuang & Hyde 2001a)
- Plectania rhytidia* (Berk.) Nannf. & Korf 皱纹暗盘菌 (Xu 2000a)
- Plectania nannfeldtii* Korf 南费尔特暗盘菌 (Xu 2000a)
- Polydesmia pteridoicola* W.Y. Zhuang 蕨叶多丝盘菌 (Zhuang 1999a)
- Polydesmia recta* W.Y. Zhuang 直多丝盘菌 (Zhuang 2000b)
- Proliferodiscus inspersus* (Berk. & M.A. Curtis) J.H. Haines & Dumont var. *inspersus* 层出盘菌原变种 (Zhuang 1998b)
- Sarcoscypha mesocyptha* F.A. Harr. 平盘肉杯菌 (Zhuang 2000c)
- Sarcoscypha shennongjiana* W.Y. Zhuang 神农架肉杯菌 (Zhuang 2000c)
- Scutellinia cejpai* (Velen.) Švrček 蔡氏盾盘菌 (Wang 1998)
- Scutellinia jilinensis* Z.H. Yu & W.Y. Zhuang 吉林盾盘菌 (Yu *et al.* 2000)
(mis-identified as *Scutellinia chiangmaiensis* T. Schumach., Zhuang 1994)
- Scutellinia jungneri* (P. Henn.) Clem. 琼那盾盘菌 (Wang 1998)
- Scutellinia phymatodeus* S.C. Kaushal & R. Kaushal 肿盾盘菌 (Wang 1998)
- Scutellinia sinosetosa* W.Y. Zhuang & Z. Wang 华刚毛盾盘菌 (Zhuang & Wang 1998)
- Scutellinia superba* (Velen.) Le Gal 短毛盾盘菌 (Zhuang & Wang 1998)
- Soleella chinensis* Y.R. Lin, Z. Li & S.M. Wu 中华小鞋孢盘菌 (Lin *et al.* 1995)
- Stictis stellata* Wallr. 星状点盘菌 (Zhuang & Wang 1998)
- Strossmayeria bakeriana* (Henn.) Iturriaga 贝克斯特罗盘菌 (Zhuang 1999a)
- Torrendiella guangxiensis* W.Y. Zhuang 广西小托雷盘菌 (Zhuang 1999a)
- Trichophaea pseudogregaria* (Rick) Boud. 假聚生长毛盘菌 (HMAS specimen)
- Tuber liui* A. S. Xu 刘氏块菌 (Xu 1999)
- Tuber oligospermum* (Tul. & C. Tul.) Trappe 寡孢块菌 (Xu 1999)
- Tuber xizangense* A.S. Xu 西藏块菌 (Xu 1999)
- Unguiculariopsis changbaiensis* W.Y. Zhuang 长白拟爪毛盘菌 (Zhuang 2000a)
- Unguiculariopsis damingshanica* W.Y. Zhuang 大明山拟爪毛盘菌 (Zhuang 2000a)

Urceolella crispula (P. Karst.) Boud. 壶盘菌 (Zhuang 2000b)

Velutaria rufo-olivacea (Alb. & Schwein.) Korf 丝绒盘菌 (Zhuang 1999a)

CHANGES FOR NAMES IN PREVIOUS LIST

- Albotricha acutipila* (P. Karst.) Raitv. 尖白毛盘菌 for *Dasyscyphus acutipilus* (P. Karst.) Sacc. (Raitviir 1970)
- Lachnellula agassizii* (Berk. & M.A. Curt.) Dennis 阿氏长生盘菌 for *Dasyscyphus agassizii* (Berk. & M.A. Curt.) Sacc. (Dharne 1965)
- Lachnum apalum* (Berk. & M.A. Curt.) Nannf. 软粒毛盘菌 for *Dasyscyphus apalus* (Berk. & Broome) Dennis (Spooner, 1987)
- Lachnum bicolor* (Bull.) P. Karst. 双色粒毛盘菌 for *Dasyscyphus bicolor* (Bull.) Fuckel (Karsten 1871)
- Lachnellula calyciformis* (Willd.) Dharne 萼长生盘菌 for *Dasyscyphus calyciformis* (Willd.) Rehm (Dharne 1965)
- Lachnum foliicola* Keissl. 叶生粒毛盘菌 for *Dasyscyphus foliicola* (Keissl.) F.L. Tai
- Lachnellula fuckelii* (Bres.) Dharne 富克粒毛盘菌 for *Dasyscyphus fuckelii* (Bres.) Velen. (Dharne 1965)
- Dasyscyphella nivea* (Hedw.) Raitv. 雪白小毛钉菌 for *Dasyscyphus niveus* (Hedw.) Sacc. (Raitviir 1970)
- Lachnum sclerotii* (A.L. Sm.) J.H. Haines & Dumont for *Dasyscyphus subcorticalis* (Pat.) Dennis var. *wulaiensis* S.C. Liou & Z.C. Chen (Haines & Dumont 1984)

ERRATA (Mycotaxon 67: 365-390, 1998)

Page 367, line 5	for	<i>Bisporella clavoflava</i>	read	<i>Bisporella claroflava</i>
Page 367, line 37	for	E. K. E. K. Cash	read	E. K. Cash
Page 368, lines 31-37	for	<i>Cookeiana</i>	read	<i>Cookeina</i>
Page 368, line 40	for	E. K. E. K. Cash	read	E. K. Cash
Page 369, line 1	for	<i>Coprotus maginatus</i>	read	<i>Coprotus marginatus</i>
Page 369, line 17	for	(Berk & M. A. Curt.)	read	(Berk. & Broome)
Page 373, line 11	for	(Bull.) W. Phillips	read	(Bull.: Fr.) Gray
Page 373, line 41-42	for	(Haines & Dumont 1984)	read	(WW&Z 1996)

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PHYSIOLOGICAL AND MORPHOLOGICAL VARIATION IN *OIDIODENDRON MAIUS*

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Abstract: A collection of 22 isolates of the hyphomycete *Oidiodendron maius* from soil, peat, wood, and ericoid mycorrhizas in northern Europe and North America was examined using 16 simple physiological tests, SEM, and light microscopy. Twenty-one of the isolates were similar in gross cultural morphology, in being uniformly acidophilous, in their intolerance to high salt concentrations, and in having temperature optima around 20-25 °C. SEM examination of conidia showed that although shape could vary substantially within a single chain, surface ornamentation was uniform among the isolates and because of fine asperulations on a perispore membrane. Conidiophore length, traditionally relied upon for species determinations in the genus, was too variable among the isolates to be a definitive character. The morphological, physiological, and ecological features examined did not indicate that subspecific taxa occur within *O. maius*. An isolate that had been included due to a previous misidentification, showed substantial physiological differences from the other 21 *O. maius* isolates. In addition to fine differences in culture, this isolate also had a unique conidial perispore confirming its lack of taxonomic relationship to the other isolates.

Keywords: acidophilous fungi, ericoid mycorrhiza, Hyphomycetes, *Myxotrichaceae*, taxonomy

INTRODUCTION

Oidiodendron maius Barron is a widely distributed hyphomycete with affinities to the ascomycete genus *Myxotrichum* (Hambleton, Egger & Currah 1998). Morphological characters, such as conidiophore length, critical for identification are variable and have lead to problems in identification (Hambleton & Currah 1997). Strains identified as *O. maius* have been isolated from peat, soil, humus, decaying wood, and the roots of vascular plants (Hambleton & Currah 1997, Hambleton *et al.* 1998). *Oidiodendron maius* is particularly significant because it forms endomycorrhizas with some Ericaceae (Douglas, Heslin & Reid 1989, Hambleton & Currah 1997, Currah, Niemi & Huhtinen 1999), ostensibly enabling host plants to thrive in soils that are low in nutrients and pH (Read 1983, Douglas *et al.* 1989, Currah, Tsuneda & Murakami 1993, Currah *et al.* 1999, Hambleton & Currah 2000). The diverse habitats occupied by *O. maius*,

combined with wide intraspecific variation and overlap in morphological characters among other species of *Oidiodendron*, especially *O. griseum* and *O. tenuissimum* (Hambleton *et al.* 1998), have confounded attempts to make conclusions regarding its distribution and ecological roles.

Physiological tests have been used to help answer both taxonomic and ecological questions in other groups of fungi (e.g. Hutchison 1990, Untereiner & Malloch 1999) but have not been applied in a systematic way to isolates of *Oidiodendron maius*.

The availability of 22 isolates of *O. maius* from a variety of provenances motivated us to ask the following questions: (1) Do physiological characteristics of *O. maius* vary to the same extent as morphological features? (2) Can morphological variations within *O. maius* be correlated with growth responses to a suite of simple physiological tests? and (3) Do correlations reflect substrate, host, or site of origin? To answer these questions, all 22 isolates were grown under standard conditions to obtain unique sets of cultural and morphological criteria. At the same time, isolates were grown on a variety of media with variations in pH, osmotic potential, temperature, light, and substrate. Scanning electron microscopy (SEM) was used to provide additional data concerning conidium morphology and ornamentation. The resulting data were searched for correlations using several clustering algorithms.

METHODS

Isolates (Table 1) are deposited as live cultures in the University of Alberta Microfungus Collection and Herbarium (UAMH) or maintained by the authors at the Department of Biological Sciences at the University of Alberta. Stocks were kept on corn meal agar (CMA; 17 g corn meal agar, 1 L distilled water; Difco-Bacto, Detroit, MI) at room temperature (~20 °C) in the dark.

Morphology

Three replicates of each isolate were grown as single-point-inoculated cultures on plates of CMA kept at room temperature in the dark. Colour, amount of sporulation, and topographical features (e.g. concentric rings, thickness of the mycelium, texture etc.) were noted. Mean culture diameter was calculated for each isolate after 10 days using at least two measurements from each replicate.

Slide cultures (Sigler 1993) of each isolate were mounted after nine days to allow conidiophores to develop. Mean conidiophore lengths and conidial dimensions were calculated for each isolate using at least 10 randomly chosen conidiophores and conidia. The entire procedure was repeated, months later, to determine the reliability of the conidiophore length measurements.

To prepare SEM images of conidia, mycelial plugs (2 mm x 2 mm) from three-week old cultures on CMA were viewed on a cryo-stage in a JEOL #JSM6301FXV SEM.

Growth Rates

Isolates were grown on CMA under a variety of light, temperature, pH, and osmotic treatments. Unless otherwise stated, isolates were grown at room temperature in the dark and measurements were based on three replicates of each treatment. Growth rates were calculated from the mean (of two measurements on each of three replicates) culture radius (mm) after 7, 10, 14, 17, 21, 24, 27, and 31 days.

Table 1: Isolate number, collector, and collection information (host plant, habitat, location) of 22 isolates of *O. maius*.

Isolate	Collectors	Collection Information
F-01	Currah	<i>Empetrum nigrum</i> , birch-dominated fjell, Kevo Research Station, Finland
F-02	Currah	<i>Vaccinium myrtillus</i> , birch-dominated fjell, Kevo Research Station, Finland
F-03	Currah	<i>V. vitis-idaea</i> , birch-dominated fjell, Kevo Research Station, Finland
H682	Lumley	Decomposing <i>Picea</i> sp., 15 km north of Slave Lake, Alberta
BS-DCMP	Thormann	Decaying <i>Sphagnum fuscum</i> , black spruce bog, Perryvale, Alberta
S1-P3-C-1	Hill-Rackette	<i>V. myrtilloides</i> , jack pine-aspen forest, 50 km south of Fort McMurray, Alberta
S1-P6-C-1	Hill-Rackette	<i>V. myrtilloides</i> , jack pine-aspen forest, 50 km south of Fort McMurray, Alberta
S2-P3-C-1	Hill-Rackette	<i>V. myrtilloides</i> , jack pine-black spruce forest, Fort McKay, Alberta
S2-P6-P-9	Hill-Rackette	<i>V. myrtilloides</i> , jack pine-black spruce forest, Fort McKay, Alberta
S3-P6-M-1	Hill-Rackette	<i>V. myrtilloides</i> , jack pine-blueberry-lichen hilltop, Fort McKay, Alberta
S4-P3-P-4	Hill-Rackette	<i>V. myrtilloides</i> , mechanically disturbed sand hill with blueberry and grasses, Fort McKay, Alberta
S4-P4-C-1	Hill-Rackette	<i>V. myrtilloides</i> , mechanically disturbed sand hill with blueberry and grasses, Fort McKay, Alberta
S4-P6-C-1	Hill-Rackette	<i>V. myrtilloides</i> , mechanically disturbed sand hill with blueberry and grasses, Fort McKay, Alberta
UAMH 1540	Barron (1962)	Soil, cedar bog, Guelph, Ontario (<i>ex-type</i>)
UAMH 6514	Stoyke & Currah (1991)	<i>Loiseleuria procumbens</i> , dry alpine ridge, Jasper National Park, Alberta
UAMH 7022	Xiao & Berch (1992)	<i>Gaultheria shallon</i> , 3 yr. old western hemlock site, coastal British Columbia
UAMH 8442	Douglas et al. (1989)	<i>Rhododendron</i> sp., heath meadow, Ireland
UAMH 8529	Couture, Fortin & Dalpé (1983)	<i>V. corymbosum</i> , Quebec
UAMH 8920	Hambleton & Currah (1997)	<i>Oxycoccus quadripetalus</i> , black spruce bog, Alberta
UAMH 8921	Hambleton & Currah (1997)	<i>V. myrtilloides</i> , sand dune, Alberta
UAMH 8922	Hambleton & Currah (1997)	<i>V. vitis-idaea</i> , sand dune, Alberta
UAMH 8933	Hambleton	<i>Phyllodoce empetrifomis</i> , alpine meadow, Alberta

Isolates were grown under diffuse daylight ("natural light"), and a black light (Philips F20T12-BL, 20 W) – "grolight" (Sylvania F20T12, 20 W) regime (referred to as "black light" treatment) (Hambleton & Currah 1997). Isolates were grown at six temperatures (5, 10, 15, 20, 25, and 30 °C). Temperatures were kept constant and were accurate within ± 1.5 °C. Isolates were grown on CMA at pH 3, 5, 7, 9, and 11. The pH was altered by the addition of 3 N hydrochloric acid (HCl) and 10 % potassium hydroxide (KOH) solutions.

Osmotic potential of the medium was altered using sodium chloride (NaCl) or glycerin and measured using a thermocouple psychrometer (DECAGON Thermocouple Psychrometer; model SC-10A sample changer and NT-3 nanovolt thermometer) and a series of NaCl standards of known water potentials. Isolates were grown on osmotically altered CMA including 50 % glycerin (by volume; water potential ≈ 0.21 MPa), 25 % glycerin (by volume; ≈ 0.13 MPa), unaltered CMA (isoosmotic; ≈ -0.42 MPa), 10 g NaCl (per 500 ml; ≈ -1.46 MPa), and 20 g NaCl (per 500 ml; ≈ -2.82 MPa).

Enzymatic Tests

Isolates were grown on media containing tannic acid, cellulose azure, chitin azure, potato starch, pectin, gelatin and TWEEN 20. The ability to alter these substrates was compared among the isolates and to negative controls (uninoculated media) based on observations of three replicates. Unless otherwise stated, inoculation was at room temperature in the dark. Except for tannic acid medium (TAM), media were prepared following Hutchison (1990).

Isolates were grown for one month under diffuse daylight on TAM prepared using a solution of 5 g tannic acid in 200 ml distilled water and a solution of 15 g malt extract and 20 g Difco agar in 800 ml distilled water. The two solutions were autoclaved separately, cooled, and combined before pouring. The darkening of the medium surrounding the mycelium, caused by the breakdown of tannic acid, indicated the production of polyphenol oxidases (PPO), enzymes correlated with lignin degradation. Darker medium discolouration indicated more PPO present.

The cellulose azure method described by Smith (1977) was used as an assay for cellulolytic ability. Modified Melin-Norkrans agar (MMN: 12 g Difco agar, 3.0 g Difco malt extract, 1.0 g d-glucose anhydrous, 1.0 g CaCl_2 , 0.5 g NaCl, 10 g KH_2PO_4 , 5.0 g $(\text{NH}_4)_2\text{HPO}_4$, 3.0 g $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) was used as the basal medium. MMN (20 ml) was added to 50-ml Pyrex culture tubes, autoclaved and allowed to solidify. A 2 % (w/v) cellulose-azure (Sigma Chemical Co., St. Louis, MO) solution in MMN was autoclaved, and 2 ml added to each tube using a sterile pipette. Isolates were incubated on the cellulose azure for one month. Tubes were scored based on the amount of dye released, by cellulose digestion, into the basal layer.

A similar procedure was used to prepare tubes of chitin azure. MMN lacking $(\text{NH}_4)_2\text{HPO}_4$ (20 ml) was used as the basal layer. MMN lacking $(\text{NH}_4)_2\text{HPO}_4$, but containing 1 g L^{-1} chitin azure (Sigma Chemical Co., St. Louis, MO) was used as the top layer. Tubes were inoculated for eight months and scored for colour change.

Isolates were grown for three weeks on MMN containing 2.0 g L^{-1} potato starch (B.D.H. Laboratory Chemicals Division, British Drug Houses Ltd., Poole, U.K.). Plates were flooded with iodine solution (5.0 g KI, 1.5 g I, 100 ml distilled water). The solution was decanted after several minutes and a clear zone around the mycelium in an otherwise dark plate indicated amylase activity.

Pectin media was prepared by dissolving 5 g L⁻¹ citrus pectin in MMN, autoclaving, and pouring into petri plates. Inoculated plates were incubated for weeks then flooded with a 1 % aqueous solution of hexadecylmethylammonium bromide (Sigma Chemical Co., St. Louis, MO) for six hours. A clear zone around the mycelium in an otherwise opaque background indicated pectinase activity. To aid in comparison, *Trichoderma harzianum*, was used as a positive control.

Gelatinase was detected using a modification of the procedure described by Hutchison (1990). MMN with 60 ml gelatin L⁻¹ (Unflavoured Knox Gelatine) instead of agar was used. The gelatin was added to 900 ml distilled water, dissolved, and autoclaved. The remaining ingredients were dissolved in 100 ml distilled water and autoclaved separately. The salt medium was added to the cooled gelatin before pouring into petri plates. Inoculated plates were incubated for three weeks. Gelatinase synthesis was indicated by liquefaction of the medium beneath the mycelium.

MMN containing 0.1 g CaCl₂ L⁻¹ was used to detect lipase synthesis. 10 ml TWEEN 20 (polyoxyethylene sorbitan monolaurate) L⁻¹ was autoclaved separately and added to the autoclaved agar before pouring. Isolates were incubated on the TWEEN medium for three months. Lipase production caused the precipitation of the calcium salt of the fatty acid released by lipolysis, forming macroscopically visible crystals beneath and around the mycelium.

Data Analyses

Mean growth rates of all 22 isolates under the natural light and black light treatments were compared using a paired, two-tailed t-test to determine if there were significant differences in the growth rates between the two treatments. The same test was used to determine whether the growth rates under the 20 °C and isoosmotic treatments (the two controls) were different. A one-way ANOVA was performed to determine if any of the isolates had significantly different conidiophore lengths. Two-tailed t-tests were performed for each isolate to determine the extent of variation between the two sets of conidiophore measurements.

Isolates were compared on the basis of the results of the growth rates, enzymatic tests, and conidium and conidiophore dimensions. Dendrograms based on these characters were constructed by neighbour joining and unweighted arithmetic averages using the Bray-Curtis, Euclidean, Mean Censored Euclidean, and Canberra measures of distance in a clustering program (<http://www.biology.ualberta.ca/jbrzusto/cluster.php>) (Brzustowski 2001).

RESULTS

Morphology

Gross cultural morphology was similar for all but one of the isolates. At ten days, the colonies were off-white to grey and flat around the periphery but higher near the centre where conidiophores and conidia were abundant. Conidiophores were dematiaceous, erect, and visible beneath the conidia with a dissecting microscope. Culture reverse was dark brown to black, especially at the centre. After 10 days on CMA, colonies were 9–18 mm in diameter (mean 13 mm; Table 2). H682 had conidia with darker pigmentation than the other isolates, causing the culture to appear grey to green-grey, rather than off-white. It also grew fastest and had the greatest diameter of all isolates after 10 days (18

mm; Table 2). UAMH 7022 was the same colour as the other isolates, but was concentrically zonate.

Table 2: (Minimum) - mean - (maximum), colony diameters (number of replicates ≥ 6) of 22 test isolates after 10 days incubation on CMA at room temperature in the dark.

Isolates	Diameter (mm)
F-01	(11) - 12 - (13)
F-02	(11) - 13 - (15)
F-03	(12) - 13 - (15)
H682	(15) - 18 - (20)
BS-DCMP	(12) - 13 - (14)
S1-P3-P-4	(10) - 11 - (12)
S1-P6-C-1	(10) - 10 - (12)
S2-P3-C-1	(13) - 14 - (16)
S2-P6-P-9	(9) - 11 - (12)
S3-P6-M-1	(8) - 10 - (12)
S4-P3-P-4	(8) - 9 - (11)
S4-P4-C-1	(10) - 11 - (12)
S4-P6-C-1	(11) - 12 - (14)
UAMH 1540	(14) - 15 - (15)
UAMH 6514	(10) - 12 - (13)
UAMH 7022	(13) - 14 - (16)
UAMH 8442	(12) - 13 - (13)
UAMH 8529	(11) - 12 - (14)
UAMH 8920	(12) - 14 - (15)
UAMH 8921	(12) - 12 - (14)
UAMH 8922	(14) - 14 - (15)
UAMH 8933	(14) - 15 - (15)
Mean	13

Overall, the mean conidiophore length (Table 3) was 174 μm (average of the two sets of measurements) and the mean conidial dimensions were $3.3 \pm 0.3 \mu\text{m} \times 1.4 \pm 0.2 \mu\text{m}$ (Table 3). There were significant differences in conidiophore length among the isolates ($p < 0.05$ for both sets of measurements). In addition, conidiophore lengths varied substantially within isolates (Table 3). Thirteen of the isolates displayed significant variation ($p < 0.05$) between the sets of measurements taken on separate cultures at different times, with six isolates showing highly significant variation ($p < 0.001$) between measurements. There was also substantial variation within single sets of measurements, for instance, conidiophores of UAMH 7022 ranged in length from 123 to 455 μm in the second set of measurements (Table 3).

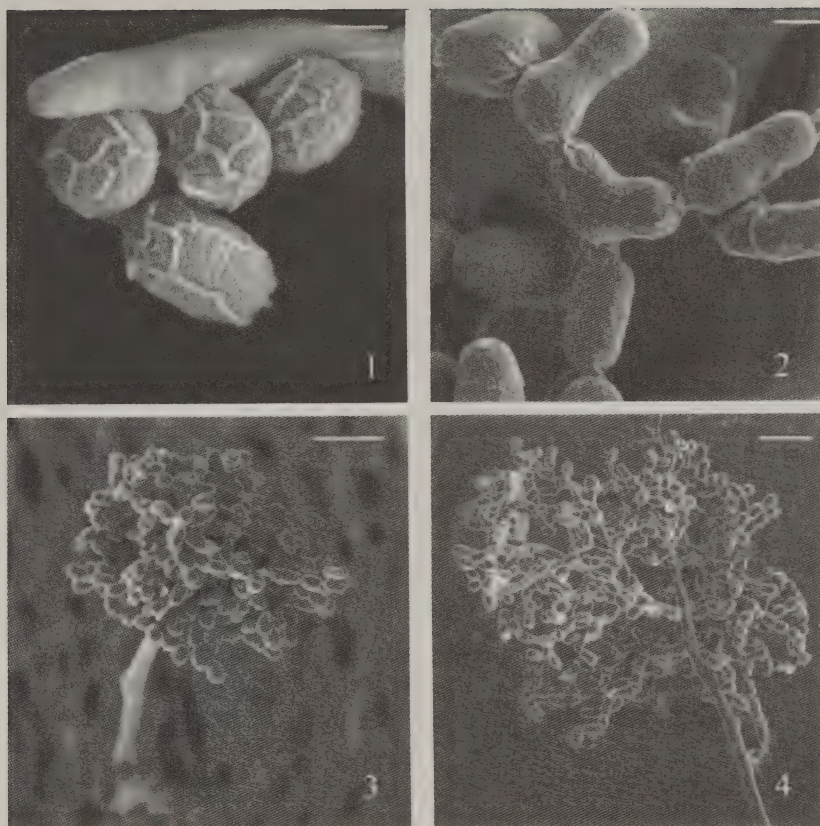
With the exception of H682, variation in conidial size and ornamentation among the isolates was minimal. The conidia of all 22 isolates were covered by a perispore, remaining from the cell wall of the conidiogenous hypha. In H682, the perispore was highly wrinkled, forming a coarse polygonal reticulum on the conidial surface (Fig. 1). The perispore was faintly asperulate or roughened, rather than wrinkled, in the other isolates (Fig. 2). Conidia were ovoid to cylindrical or slightly dumbbell-shaped, or Y-shaped when arising from branch points in the fertile hyphae (Fig. 2). Increasing maturity of the conidiogenous hyphae resulted in a mass of arthroconidia loosely

Table 3: Minimum, mean, and maximum conidiophore lengths (μm) (from two independent slide cultures) and conidial dimensions (length x width) (μm) ($n \geq 10$) of the 22 isolates. Maximum and minimum values are in parentheses. Statistically significant differences in conidiophore lengths between the measurements are noted (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, n.s. = not significant).

Isolates	Conidiophore lengths (1)	Conidiophore lengths (2)	Conidial Dimensions
F-01	(90)-115-(148)	(45)-73-(108)	*** (2.7)-3.4-(4.5)x(1.0)-1.3-(1.5)
F-02	(113)-138-(190)	(83)-133-(173)	n.s. (2.0)-3.1-(4.3)x(1.0)-1.1-(1.5)
F-03	(63)-88-(110)	(78)-148-(250)	*** (2.0)-3.2-(4.0)x(1.0)-1.3-(1.7)
H682	(113)-203-(260)	(90)-152-(215)	** (2.5)-3.2-(4.0)x(1.0)-1.7-(2.5)
BS-DCMP	(185)-261-(340)	(120)-237-(300)	n.s. (2.5)-3.4-(4.2)x(1.0)-1.4-(2.0)
S1-P3-C-1	(95)-130-(148)	(60)-154-(208)	** (2.4)-3.3-(4.0)x(1.0)-1.6-(2.0)
S1-P6-C-1	(100)-163-(225)	(73)-135-(190)	* (2.4)-3.3-(4.0)x(1.0)-1.6-(2.0)
S2-P3-C-1	(140)-166-(195)	(78)-162-(240)	n.s. (2.5)-3.4-(4.0)x(1.0)-1.3-(1.5)
S2-P6-P-9	(200)-245-(295)	(133)-210-(350)	* (2.5)-3.4-(4.0)x(1.0)-1.4-(1.8)
S3-P6-M-1	(80)-111-(145)	(90)-153-(200)	*** (2.5)-3.3-(5.0)x(1.0)-1.4-(2.0)
S4-P3-P-4	(175)-247-(300)	(155)-222-(280)	* (3.0)-3.5-(4.0)x(1.0)-1.4-(1.5)
S4-P4-C-1	(155)-239-(340)	(115)-257-(355)	n.s. (2.5)-3.4-(4.0)x(1.0)-1.4-(2.0)
S4-P6-C-1	(80)-135-(210)	(83)-167-(258)	* (2.0)-2.9-(3.5)x(1.0)-1.5-(2.0)
UAMH 1540	(165)-245-(320)	(140)-234-(345)	n.s. (2.5)-3.0-(3.5)x(1.0)-1.3-(1.5)
UAMH 6514	(113)-153-(205)	(130)-233-(430)	*** (2.5)-3.0-(4.0)x(1.0)-1.5-(2.0)
UAMH 7022	(123)-174-(275)	(123)-286-(455)	*** (2.5)-3.4-(4.5)x(1.0)-1.4-(1.5)
UAMH 8442	(95)-159-(225)	(98)-159-(228)	n.s. (2.5)-3.7-(5.0)x(1.0)-1.4-(2.0)
UAMH 8529	(75)-90-(105)	(55)-86-(123)	n.s. (2.0)-3.2-(4.0)x(1.0)-1.2-(1.5)
UAMH 8920	(108)-158-(195)	(165)-239-(330)	*** (2.5)-3.8-(5.0)x(1.5)-1.9-(2.5)
UAMH 8921	(65)-118-(160)	(63)-114-(153)	n.s. (2.5)-3.8-(4.2)x(1.0)-1.6-(2.0)
UAMH 8922	(140)-232-(308)	(120)-233-(350)	n.s. (2.0)-3.0-(4.0)x(1.0)-1.3-(2.5)
UAMH 8933	(133)-159-(215)	(83)-132-(203)	* (2.5)-3.6-(5.0)x(1.0)-1.4-(1.5)
Mean $\pm$ S.D.	170 $\pm$ 54	178 $\pm$ 58	n.s. 3.3 $\pm$ 0.25 x 1.4 $\pm$ 0.18

Table 4: Mean growth rates (mm d^{-1}) of 22 isolates of *O. maius* grown under different light regimes (NL=natural light, BL=black light), temperature ($^{\circ}\text{C}$), pH, and osmotic (iso=isoosmotic (unaltered CMA), 10 g=10 g NaCl/500ml CMA, 20 g=20 g NaCl/500 ml CMA) conditions.

Isolates	NL	BL	5°C	10°C	15°C	20°C	25°C	30°C	pH 3	pH 5	pH 7	pH 9	pH 11	Iso	10g	20g
F-01	0.59	0.57	0.04	0.17	0.34	0.62	0.44	0.06	0.82	0.68	0.43	0.29	0.07	0.62	0.36	0.13
F-02	0.71	0.66	0.05	0.13	0.37	0.65	0.73	0.16	0.86	0.72	0.49	0.28	0.07	0.61	0.35	0.12
F-03	0.70	0.64	0.05	0.15	0.38	0.65	0.79	0.10	0.77	0.69	0.55	0.32	0.07	0.68	0.31	0.10
H682	0.82	0.70	0.22	0.33	0.30	0.78	0.50	0	0.56	0.95	0.99	0.98	0.96	1.01	1.05	0.72
BS-DCMP	0.62	0.60	0.05	0.15	0.38	0.66	0.66	0.27	0.84	0.73	0.43	0.26	0.09	0.65	0.44	0.14
S1-P3-C1	0.61	0.59	0.04	0.13	0.33	0.59	0.59	0.07	0.93	0.73	0.34	0.20	0.05	0.53	0.36	0.11
S1-P6-C1	0.52	0.60	0.04	0.14	0.32	0.52	0.50	0.15	0.96	0.73	0.37	0.18	0.03	0.50	0.33	0.11
S2-P3-C1	0.75	0.75	0.05	0.15	0.35	0.69	0.77	0.26	0.88	0.81	0.54	0.31	0.07	0.75	0.38	0.10
S2-P6-P9	0.54	0.56	0.05	0.14	0.35	0.55	0.43	0.16	0.76	0.66	0.34	0.23	0.06	0.57	0.34	0.13
S3-P6-M1	0.57	0.55	0.03	0.11	0.27	0.55	0.48	0.06	0.90	0.77	0.32	0.13	0.05	0.43	0.28	0.12
S4-P3-P4	0.46	0.51	0.05	0.12	0.33	0.50	0.57	0.04	0.91	0.68	0.30	0.18	0.02	0.42	0.33	0.11
S4-P4-C1	0.58	0.53	0.04	0.17	0.37	0.50	0.38	0.13	0.78	0.64	0.25	0.23	0.07	0.56	0.37	0.11
S4-P6-C1	0.61	0.53	0.04	0.14	0.36	0.57	0.40	0.02	0.78	0.64	0.39	0.24	0.06	0.61	0.32	0.13
UAMH 1540	0.72	0.74	0.04	0.15	0.40	0.72	0.73	0.05	0.95	0.82	0.61	0.32	0.08	0.73	0.36	0.09
UAMH 6514	0.50	0.56	0.05	0.16	0.31	0.54	0.61	0.07	0.89	0.59	0.41	0.26	0.07	0.66	0.34	0.09
UAMH 7022	0.77	0.79	0.05	0.16	0.38	0.71	0.91	0.18	0.94	0.83	0.57	0.43	0.06	0.68	0.42	0.14
UAMH 8442	0.64	0.65	0.03	0.18	0.38	0.59	0.67	0.07	0.98	0.73	0.47	0.37	0.07	0.67	0.38	0.15
UAMH 8529	0.72	0.73	0.04	0.13	0.33	0.62	0.72	0.34	0.91	0.69	0.41	0.19	0.08	0.56	0.39	0.13
UAMH 8920	0.71	0.61	0.05	0.16	0.35	0.64	0.54	0.15	0.90	0.83	0.48	0.27	0.06	0.72	0.43	0.16
UAMH 8921	0.64	0.70	0.03	0.15	0.33	0.60	0.65	0.09	0.94	0.72	0.37	0.16	0.04	0.56	0.33	0.09
UAMH 8922	0.76	0.75	0.05	0.18	0.38	0.71	0.76	0.06	0.89	0.83	0.57	0.37	0.06	0.73	0.41	0.11
UAMH 8933	0.69	0.72	0.03	0.16	0.38	0.73	0.71	0.06	0.82	0.70	0.57	0.37	0.09	0.73	0.41	0.09
Mean	0.65	0.64	0.05	0.16	0.35	0.62	0.62	0.12	0.86	0.73	0.46	0.30	0.10	0.63	0.39	0.14



Figs. 1-4. Cryostage SEM images of conidia and conidiophores of four isolates identified as *Oidiiodendron maius*. **Fig. 1.** Conidia of isolate H682 *ex* decaying spruce log, Alberta. The wrinkled (reticulate) perispore indicated the species is anomalous among other isolates of *O. maius*, bar = 1 μ m. **Fig. 2.** Portion of fertile hyphae from conidial head of UAMH 8442 *ex* *Rhododendron*, Ireland. Perispore is asperulate. Arthroconidial chains branch at Y-shaped conidia. Intervening spaces are areas where the cell wall has collapsed, bar = 1 μ m. **Fig. 3.** Conidia and conidiophore of UAMH 8921 *ex* *Vaccinium myrtilloides*, Alberta. The large head of fertile hyphae bears mature ovoid conidia at the tips of arthroconidial chains. The asperulate nature of the perispore and the connections between conidia where the cell walls have collapsed are apparent, bar = 5 μ m. **Fig. 4.** Conidia and conidiophore of S3-P6-M-1 *ex* *Vaccinium myrtilloides*, Alberta. The branching pattern is approximately verticillate. Distal, older conidia are ovoid while more proximal conidia are barrel or dumbbell shaped, bar = 10 μ m.

attached, end-on-end, by the contracted remains of the parent hyphal walls (Figs 2, 3). Variations in conidial shape were related to position in the chains, with distal, older conidia ovoid and more proximal conidia barrel or dumbbell-shaped (Fig. 4). The branching pattern of the conidiogenous hyphae from the central conidiophore apex was approximately verticillate (Figure 4).

Growth Rates

Mean growth rates (mm d^{-1}) of each isolate for each treatment are in Table 4. There was considerable variation in growth rates among and within treatments and isolates. Two treatments (20 °C and isoosmotic) involved the same growing conditions (room temperature, unaltered CMA, and darkness) but were set up about two months apart. While there were no significant differences in mean growth rates between the two treatments ($p>0.05$), the growth rate of some isolates, such as H682, varied substantially between the two treatments (Table 4) and there was greater variation in the mean growth rates among the isolates in the isoosmotic treatment (0.42–1.01 mm d^{-1} compared to 0.50–0.78 mm d^{-1} in the 20 °C treatment).

Overall, there were no significant differences in mean growth rates under black and natural light ($p>0.05$) (Table 4). However, there was considerable variation among the isolates in response to each treatment, with ranges of 0.46–0.82 mm d^{-1} under natural light and 0.51–0.79 mm d^{-1} under black light (Table 4).

Growth rates were highest at intermediate temperatures, with mean maxima between 20 and 25 °C (mean 0.62 mm d^{-1} ; Table 4). Growth rates were lowest at 5 °C for all isolates except H682, which had its minimum at 30 °C and had a growth rate of 0.22 mm d^{-1} at 5 °C (Table 4). Some isolates reached maximal growth rates at 20 °C, while others had maximal growth rates at 25 °C (Table 4). While there was variation in response to each treatment, variation was greatest at higher temperatures (Table 4).

On average, growth rates were highest at pH 3 (0.86 mm d^{-1}) then decreased to a minimum of 0.10 mm d^{-1} at pH 11 (Table 4). The exception was isolate H682, which had its minimum at pH 3 (0.56 mm d^{-1}) and maximum at pH 7 (0.99 mm d^{-1}), with growth rates greater than 0.95 mm d^{-1} from pH 5–11 (Table 4). Variation among the isolates in response to the pH treatments increased as pH increased (Table 4).

None of the isolates grew on media containing glycerin. For all isolates except H682, growth rates decreased with increased salt concentration and osmotic potential, from a mean of 0.63 mm d^{-1} on the isoosmotic control to a mean of 0.14 mm d^{-1} in the medium containing 20 g NaCl per 500 ml (Table 4). H682 grew faster on the medium containing 10 g salt than at isoosmotic conditions (1.04 and 1.01 mm d^{-1} , respectively) and grew faster than any of the other isolates on 20 g NaCl (Table 4). Variation in growth rates was high for all three treatments (isoosmotic, 10 g NaCl, and 20 g NaCl) (Table 4).

Enzymatic Tests

Enzymatic ability was assessed qualitatively and the results are provided in Table 5. No degradation is indicated by ‘-’, slight by ‘+’, moderate by ‘++’, and high by ‘+++’.

All isolates, except H682, grew on the TAM and caused the formation of a brown pigment beneath the mycelium, indicating the production of PPO (Table 5). H682 did not grow on TAM or cause a pigment change in the medium (Table 5). UAMH 7022 showed the most intense pigmentation (Table 5). The depth of colour and

the length of time needed to detect positive reactions varied among isolates; however, most isolates caused moderate amounts of pigmentation (Table 5) within two weeks.

Positive reactions from the cellulose azure were obtained for all isolates (Table 5). BS-DCMP produced the greatest colour change in the basal medium, while H682, S3-P6-M-1, and S4-P3-P-4 showed slight colour change (Table 5). The remainder of the isolates displayed moderate colour change (Table 5) within two weeks.

Positive reactions from the chitin azure took eight months to develop. Isolates grew well on the chitin-enhanced medium and only H682 failed to produce a colour change in the basal medium after eight months. Isolates F-03 and BS-DCMP released the greatest amounts of azure into the basal medium (Table 5).

All isolates, except H682, degraded starch, but F-01, BS-DCMP, S4-P3-P-4, and UAMH 8933 showed only moderate amylase activity relative to the other isolates, which had more pronounced amylase activity (Table 5).

All isolates demonstrated slight pectinolytic ability (Table 5) when compared to the positive control. UAMH 8921 had the greatest pectinolytic ability and was designated moderately pectinolytic (Table 5).

All isolates liquefied the gelatin medium (Table 5) but F-03, S4-P4-C-1, and UAMH were weakly gelatinolytic compared to the other isolates, while H682 and UAMH 8922 caused the greatest liquefaction (Table 5).

None produced a precipitate in the TWEEN-enhanced medium (Table 5) but all grew well on the medium. Substantial variation in morphology occurred on this medium, with some isolates producing coloured (yellow, orange, brown, and dark brown) exudates and some mycelia becoming pigmented (yellow, orange-brown, and dark brown). Conidial production and culture texture ranged from highly sporulating and floccose to non-sporulating and slimy.

Table 5: Enzymatic abilities of the 22 isolates ((-) = no reaction, (+) = slight reaction, (++) = moderate reaction, (+++) = strong reaction).

Isolates	Lignin	Cellulose	Chitin	Starch	Pectin	Gelatin	Lipid
F-01	+	++	+	++	+	++	-
F-02	+	++	+	+++	+	++	-
F-03	++	++	++	+++	+	+	-
H682	-	+	-	-	+	+++	-
BS-DCMP	++	+++	++	++	+	++	-
S1-P3-C-1	++	++	+	+++	+	++	-
S1-P6-C-1	++	++	+	+++	+	++	-
S2-P3-C-1	++	++	++	+++	+	++	-
S2-P6-P-9	++	++	+	+++	+	++	-
S3-P6-M-1	++	+	++	+++	+	++	-
S4-P3-P-4	++	+	+	++	+	++	-
S4-P4-C-1	++	++	+	+++	+	+	-
S4-P6-C-1	++	++	++	+++	+	++	-
UAMH 1540	++	++	++	+++	+	+	-
UAMH 6514	++	++	++	+++	+	++	-
UAMH 7022	+++	++	+	+++	+	++	-
UAMH 8442	++	++	++	+++	+	++	-
UAMH 8529	+	++	+	+++	+	++	-
UAMH 8920	++	++	+	+++	+	++	-
UAMH 8921	++	++	++	+++	++	++	-
UAMH 8922	++	++	++	+++	+	+++	-
UAMH 8933	++	++	++	++	+	+	-

Cluster Analyses

Neither neighbour joining nor unweighted arithmetic averages provided clear results. The dendrograms produced using the distance measures were not well supported by bootstrap analysis, with few branches receiving greater than 50 % support. The trees are not shown. However, H682 was always on its own branch but other isolates did not form well-supported groups.

DISCUSSION

In spite of considerable variation in morphological and physiological characteristics, 21 of the 22 isolates were apparently conspecific and satisfactorily placed in *Oidiodendron maius*. These isolates were similar in gross cultural morphology, in being uniformly acidophilous (growing optimally at pH 3), in their intolerance to high salt concentrations, and in having temperature optima around 20-25 °C. SEM examination of conidia showed that although shape could vary within a single chain, surface ornamentation in the 21 conspecific isolates was constant and due to fine asperulations on a perispore membrane.

However, conidiophore length, one of the traditional characteristics used to define the species was too variable to be a reliable character. Mean conidiophore length varied from 73 µm in isolate F-01 to 286 µm in UAMH 7022 (Table 3) and varied within an isolate depending on unknown factors associated with the time of preparation of slide cultures. Substantial variation was also observed within a single slide culture. Variation in conidiophore length in *Oidiodendron maius* has been noted before (Tokumasu 1973, Hambleton & Currah 1997, Hambleton *et al.* 1998); however, this study systematically examined this variation. All keys so far published to this genus (Barron 1962, Domsch, Gams & Anderson 1980) rely on conidiophore length as a key character. This is unfortunate given its unreliability in this and similar species (Hambleton *et al.* 1998). More reliable and distinctive characters may be found in physiological tests and features visible using SEM.

Among our isolates, H682, was obviously an outlier. Gross cultural morphology and characters derived from light microscopic examination of this isolate had placed it in *Oidiodendron maius*. Physiologically, it differed considerably from the other 21 isolates in that it had a pH optimum between 7 and 9, a predilection for high salt environments, and was more psychrotolerant than *O. maius*, having much higher growth rates than the other isolates at lower temperatures (Table 4). However, the growth rates of H682 approached those of the other isolates at higher (>20 °C) temperatures (Table 4). Conidia of H682, by SEM, showed variation in conidial shape within that accepted for *O. maius* but the perispore was coarsely wrinkled rather than asperulate, a character scarcely detectable by routine light microscopy. This isolate was unable to degrade tannic acid, starch, and chitin, unlike other isolates. Morphological characteristics in keys did not allow confident placement of this isolate under a different species name. The conidia of this isolate were darker in colour than in the *O. maius* isolates and the broad wrinkles on the perispore gave the conidia a slightly flat-sided or truncate appearance with the light microscope, a feature characteristic of *O. truncatum* (Barron 1962). Identification of this isolate remains tentative until a comparison can be made to *ex-type* or authentic material.

Correlations among characters indicating subspecific taxa were not found in the *O. maius* isolates. The three isolates from the fjell in Finland (F-01, F-02, and F-03)

were no more similar to each other than to the North American isolates. The three Finnish isolates had shorter than average conidiophores but there was considerable variation in this character. Their growth rates and enzymatic abilities were similar to each other but also to many of the North American isolates. Similarly, there were no correlations among isolates from bogs or from sand hills. The three isolates from bogs (BS-DCMP, UAMH 1540, and UAMH 8920) had conidiophores that were longer than average but there was considerable variation among them and the variation among their growth rates and enzymatic abilities was comparable to that among all 21 isolates. Even isolates obtained from the same study sites varied considerably in their morphology and physiology. For example, the three isolates from the disturbed hilltop near Fort McKay, Alberta (S4-P3-P-4, S4-P4-C-1, and S4-P6-C-1) showed variable growth rates and enzymatic abilities, as did the two isolates from the pine forest near Fort McMurray, Alberta (S1-P3-C-1 and S1-P6-C-1). Likewise, host plant of origin had no apparent correlation with morphological and physiological traits. The isolates obtained from the roots of *Vaccinium myrtilloides* spanned most of the range of variability present among all 21 isolates and did not differ substantially from isolates from other plants and substrates.

Enzymatic tests indicate that *O. maius* can degrade lignin and cellulose. This is compatible with its predilection for roots and decaying plant material. Its ability to degrade other substrates, including chitin, pectin, and gelatin, is compatible with previous work showing that *Hymenoscyphus ericae*, another ericoid mycorrhizal fungus, is enzymatically diverse and can attack complex forms of organic nitrogen (Read 1983, Leake & Read 1989, Leake & Read 1990). It has been proposed that enzymatic diversity among ericoid mycorrhizal fungi enables host plants to thrive in harsh, nutrient poor, acidic environments (Hambleton & Currah 2000). However, because it took eight months for positive reactions to occur on the chitin azure, possibly due to the coarse nature of the substrate, this is not a practical test for routine work.

The 21 *O. maius* isolates were uniformly acidophilous, growing optimally at pH 3. This character correlates well with the observation that *O. maius* is frequently isolated from acidic habitats, such as bogs. Hambleton and Currah (1997) reported that *O. maius* was proportionally more common among ericoid mycorrhizal endophytes in roots of plants growing in bog habitats than in alpine and sand dune habitats. Conversely, the more alkaline sand dune habitats had a greater relative abundance of *Phialocephala fortinii* than *O. maius* (Hambleton & Currah 1997). These relative abundance data probably reflect the acidophilous nature of *O. maius* and a higher pH optimum of *P. fortinii* (unpublished data).

No correlations were found among morphological and physiological variants as indicated by the lack of support in clustering analyses. In addition, the morphological and physiological variation was not linked to specific substrates, hosts, or geographical locations. This level of variation among isolates indicates sexual recombination is probably occurring although a sexual stage for *O. maius*, expected in the genus *Myxotrichum*, has not yet been described. The ascomata of other species in *Myxotrichum* are minute (less than 1 mm diam.), cleistothecial, and are only rarely found in nature (Currah 1985) or in culture (Uchiyama, Kamiya & Udagawa 1995, Udagawa & Uchiyama 1999, Lumley, Abbot & Currah 2000). Greater attention to the physiological requirements of the *O. maius* anamorph may lead to the discovery of the teleomorph and an explanation of the variation in the taxon.

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WENYINGIA, A NEW GENUS IN PEZIZALES (OTIDEACEAE)

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ABSTRACT A new genus *Wenylingia* (Otideaceae, Pezizales), based on *Wenylingia sichuanensis*, a new species, is reported from western Sichuan, China. An unusual membrane covering the hymenium, the structure and origin of which are discussed in this paper, distinguishes this genus from others in the family. The structure of the excipulum, size, shape and ornamentation of spores and pigmentation of the apothecia place this genus close to *Tarzetta*.

KEY WORDS: Discomycetes, China

INTRODUCTION

Many fungi were collected in western Sichuan Province in China in the summer of 1997 by botanists and mycologists from the Harvard University Herbaria, the Institute of Botany, Chinese Academy of Sciences and the Institute of Microbiology, Chinese Academy of Sciences. Among the specimens collected, we found a fungus that could not be placed in any existing genus of the Pezizales. It is described here as a new genus.

Wenylingia sichuanensis Zheng Wang & Pfister, **gen. et sp. nov.**

Fig. 1

Apothecia cupulata, stipitata, brunneo, usque 10mm diam, 22mm altitudo. Excipulum ectal e cellulis brunneo, angularibus 5-20µm diam (textura angulari), excipulum medullare ex hyphis brunneae. Compositum. Asci octospori, crasse tunicati, cylindranei,

270-295 x 13.5-16µm. *Ascospores ellipsoidei, biguttulati*, 19-21.5 x 11-12µm.

Apothecia cupulate, stiptate, outside pale-brown to buff, up to 10mm diam, 22mm high when fresh; strongly concave when dry. **Hymenium** 250µm thick, dark-brown when dry, covered by a thin, white, spider web-like membrane originating from parallel hyphae at the margin, hyphae forming the covering 10-21µm diam. **Ectal excipulum** of *textura angularis*, ca (65-) 85-100µm thick; cells brownish, 5-20µm diam. **Medullary excipulum** of *textura intricata*, brown, 75-150µm thick. **Asci** 8-spored, operculate, thick walled, J-, cylindrical, tapering to the base, ca 270-295 x 13.5-16µm. **Ascospores** ellipsoid to ovoid, with two conspicuous oil drops, smooth-walled, 19-21.5 x 11-12µm. **Paraphyses** cylindrical, septate, prominently branched midway, 2-3µm wide below, 4-6µm above, sometimes slightly swollen and deformed at apex.

Holotype: CHINA, Sichuan Province, Luding Xian, Gongga Shan, Camp 2, mixed broad-leaved deciduous forest with *Picea* and *Taxus*, 29°35'11"N, 102°1'40"E, on bare soil, 19 Aug 1997, Zheng Wang (2088) (HMAS 75909, isotype: FH)

Etymology: *Wenyungia*, in honor of Professor Wen-ying Zhuang, discomycetes specialist and leader of the Systematic Mycology and Lichenology Laboratory, Chinese Academy of Sciences.

COMMENTS

The most distinctive aspect of *Wenyungia sichuanensis* is the presence of a very thin membrane covering the hymenium. It initially appeared to be the remains of a spider's web. Such a covering on a mature member of the Pezizales is unusual. The excipular layers are distinct delimited and the ectal excipulum is composed of distinctive angular cells. These features, along with the absence of carotenoid pigments place *Wenyungia* in the Otideaceae, close to *Tarzettia*. In addition, the ascospores are smooth, and there are two prominent guttules; these are characters shared with *Tarzettia* (Cooke) Lamb. and *Otidea* (Pers.) Bonord.

The most apparent and important difference between this species and all other genera in Otideaceae is the membrane mentioned above. The membrane forms a continuous layer over the hymenium and is not broken at maturity. It appears to be a barrier to ascospore discharge. Discharge of ascospores was not observed nor were functional opercula. There is little evidence in the ascocarp to suggest a specialized discharge/dispersal apparatus or mechanism. Research on living material will be necessary for the biology of this fungus to be understood. From anatomical sections we found that the membrane is part of a layer continuous with the cells at the margin of the disc. It forms a dome, which encloses the entire hymenium. Although the interpretation of this structure is uncertain in regards to development or phylogeny, its presence provides reasonable justification for recognition of this taxon at the level of genus. There seems to be no epigeous or hypogeous taxon to which this material might be referred.

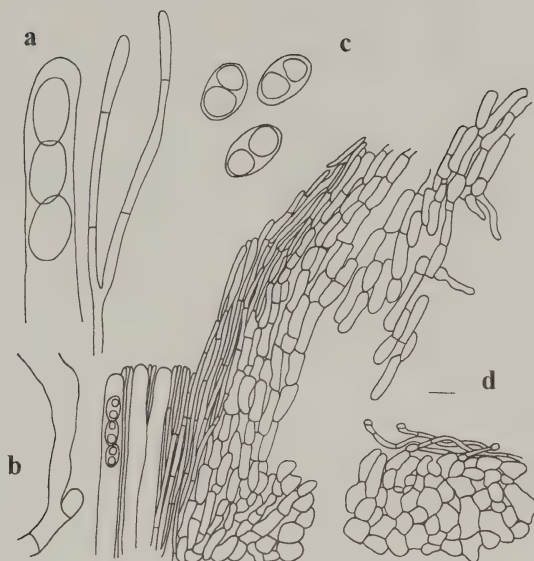


Fig 1. *Wenyingia sichuanensis* (HMAS 75909) **a**) apex of ascus and paraphyses **b**) base of ascus **c**) ascospores **d**) excipulum near margin and towards the base. scale = 20 μ m.

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COMPLÉMENTS À L'INVENTAIRE DES BASIDIOMYCÈTES DE GRÈCE

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Resumé

Dans ce travail sont présentées 190 espèces de Basidiomycètes, inventoriées pour la première fois en Grèce. Ces espèces ont été collectées et identifiées à la suite des prospections réalisées surtout dans des écosystèmes forestiers de la Grèce centrale, sur la période 1994-1999, pendant laquelle 485 espèces ont été déterminées au total.

Les résultats de ce travail nous incitent à continuer l'effort de prospection dans d'autres peuplements forestiers dans le reste du pays, afin de contribuer à établir une liste complète de la mycoflore grecque.

Abstract

In the present work, 190 Basidiomycetes species recorded for the first time in Greece are presented. These species have been collected during surveys mainly realised in forest ecosystems of central Greece in the period 1994-1999 resulting in the determination of a total number of 485 species.

The results incite us to realise more surveys in other forest communities over the rest of the country in order to contribute to the preparation of an updated list of the Greek mycoflora.

Key-Words: biodiversity, Greece, macromycetes, mycoflora, new records.

INTRODUCTION

La biodiversité des macromycètes (Basidiomycètes et Ascomycètes) constitue pour les écosystèmes forestiers un indicateur important de stabilité écologique et de situation sanitaire, étant donné le rôle fondamental que les champignons jouent dans les équilibres biologiques de biocénoses diverses. En effet, les espèces saprotrophes décomposent la matière organique morte et participent de cette façon au recyclage des éléments minéraux de la nature. D'autre part, les espèces symbiotiques assurent la symbiose mycorhizienne, qui contribue considérablement à une nutrition minérale améliorée des plantes partenaires. La détermination de la macroflore fongique est donc un préalable indispensable pour l'étude de cette biodiversité.

Dans notre pays un effort d'inventaire de la mycoflore endémique dans différentes régions a été réalisé au cours des dernières décennies (Avtzis & Diamandis, 1988 ; Athanassiou & Theochari, 1999 ; Diamandis, 1983, 1985, 1992 ; Diamandis & Minter, 1981, 1983 ; Diamandis & Perlerou, 1990, 1994 ; Keltemlidis, 1990 ; Pantidou, 1980, 1990 ; Pantidou & Gonou, 1984 ; Pantidou & Watling, 1970). Citons aussi un autre travail remarquable, réalisé antérieurement (Maire & Politis, 1940). Les espèces déterminées au cours de ces travaux représentent un nombre très faible par rapport aux



Tableau 1. Carte géographique de la Grèce avec les régions prospectées.

Régions	Sites prospectées	Altitude	Roche-mère
Ile d'Eubée	Futaie pure de <i>Pinus nigra</i> J. F. Arnold à Kerassia	690 m	Péridotites
	Futaie mixte d' <i>Abies borisii-regis</i> Mattf. (elle est considérée comme un hybride entre <i>Abies cephalonica</i> Loudon et <i>Abies alba</i> Mill.), de <i>Pinus nigra</i> J. F. Arnold et de <i>Quercus</i> spp. à Kerassia	640 m	Péridotites
	Futaie mixte de <i>Quercus</i> spp. et d' <i>Abies borisii-regis</i> Mattf. à Papades	530 m	Péridotites et calcaire
	Futaie pure de <i>Quercus frainetto</i> M. Tenore à Papades	520 m	Péridotites et calcaire
	Futaie mixte de <i>Pinus nigra</i> J. F. Arnold, de <i>Pinus halepensis</i> Mill. et de <i>Quercus frainetto</i> M. Tenore à Papades	510 m	Péridotites et calcaire
	Futaie pure de <i>Pinus halepensis</i> Mill. à Vassilika	200 m	Péridotites et calcaire
Thessalie	Futaie pure de <i>Fagus moesiaca</i> (Maly) Domin au mont Kissavos	520 m	Schistes
	Futaie mixte de <i>Fagus moesiaca</i> (Maly) Domin et de <i>Castanea sativa</i> Mill. au mont Kissavos	665 m	Schistes
	Plantation de <i>Castanea sativa</i> Mill. au mont Kissavos	665 m	Schistes
	Plantation de <i>Pinus nigra</i> J. F. Arnold dans une futaie de <i>Fagus moesiaca</i> (Maly) Domin au mont Kissavos	630 m	Schistes
	Futaie mixte de <i>Fagus moesiaca</i> (Maly) Domin et d' <i>Abies borisii-regis</i> Mattf. au mont Kissavos	730 m	Schistes
	Futaie de différentes espèces de <i>Quercus</i> au mont Kissavos	75 m	Schistes
	Futaie pure d' <i>Abies borisii-regis</i> Mattf. au lac de Megdova	840 m	Flysch
	Futaie mixte d' <i>Abies borisii-regis</i> Mattf. et de <i>Quercus frainetto</i> M. Tenore au lac de Megdova	830 m	Flysch
	Futaie pure de <i>Quercus</i> spp. au lac de Megdova	820 m	Flysch
	Futaie pure de <i>Quercus</i> spp. à la région de Karditsa	100 m	Calcaire
	Futaie pure d' <i>Abies borisii-regis</i> Mattf. à Pertouli	1100 m	Flysch
	Plantation de <i>Pinus nigra</i> J. F. Arnold dans une futaie d' <i>Abies borisii-regis</i> Mattf. à Pertouli	1100 m	Flysch
	Plantation pure de <i>Pinus brutia</i> Ten. à Larissa	70 m	Alluvions
	Plantation mixte de <i>Pinus brutia</i> Ten. et de <i>Cupressus sempervirens</i> L. à Larissa	65 m	Alluvions
	Plantation de <i>Pinus pinaster</i> Aiton au mont Pélion	400 m	Schistes
Karpenissi	Futaie pure d' <i>Abies borisii-regis</i> Mattf. à Karpenissi	1350 m	Flysch

Tableau 2. Caractéristiques des régions prospectées.

espèces inventoriées dans d'autres pays d'Europe ; elles ont été présentées récemment, dans leur ensemble, par Zervakis (Zervakis *et al.*, 1998).

Dans le présent travail, nous citons, pour la première fois en Grèce, un certain nombre d'espèces de Basidiomycètes. L'inventaire a surtout été réalisé dans des écosystèmes forestiers des régions sélectionnées de la Grèce centrale et sur la période 1994-1999. La détermination des espèces a été basée sur des caractères macro-et microscopiques et elle a été réalisée à l'aide d'ouvrages qui traitent de la macroflore fongique (Breitenbach & Kränzlin, 1984 ; Courtecuisse & Duhem, 1994 ; Marchand 1971-1989, etc.). Citons que la plupart de ces espèces ont été photographiées sur place ; des spécimens séchés, pour un nombre très limité d'espèces, existent aussi dans notre herbier.

RÉSULTATS

Nous présentons, ci-dessous, 190 espèces inventoriées pour la première fois en Grèce, réparties en ordres et familles selon la classification du Dictionary of Fungi (Hawksworth *et al.*, 1995). À l'intérieur de chaque famille les espèces sont présentées par ordre alphabétique. Pour chaque taxon, nous citons aussi leur(s) habitat(s). Outre ces espèces nouvelles pour la Grèce, nous avons aussi retrouvé, durant cette période de prospection, 295 espèces déjà mentionnées dans des travaux antérieurs.

Les régions prospectées sont localisées sur la carte géographique de la Grèce, présentée dans le tableau 1. Des caractéristiques écologiques des peuplements forestiers de ces régions sont référées dans le tableau 2.

Agaricales

Agaricaceae

Agaricus bitorquis (Quél.) Sacc.. Prairie à côté de Karditsa (Thessalie).

Agaricus essettei Bon (= *Ps. abruptibulba* ss. auct. europ.). Futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie) ; futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) ; futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Agaricus niveolutescens Huijsman. Endroit herbeux dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Agaricus pampeanus Speg.. Prairie à côté d'une futaie pure d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Lepiota brunneoincarnata Chodat & Mart.. Lisière d'une plantation pure de *Pinus brutia* et plantation mixte de *Pinus brutia* et de *Cupressus sempervirens* à Larissa.

Lepiota clypeolaria (Bull.) Quél.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Lepiota grangei (Eyre) J. E. Lange (= *Lepiotula grangei*). Endroit herbeux à côté d'une plantation pure de *Pinus brutia* à Larissa (Thessalie).

Lepiota ignivolvata Joss.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie) ; futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) ; futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Leucoagaricus melanotrichus (Malençon & Bertault) Trimbach. Futaie pure de *Quercus* spp. à la région de Karditsa (Thessalie).

Macrolepiota fuliginosa (Barla) Bon. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Macrolepiota rickenii (Velen.) Bellù & Lanzoni (= *M. gracilentia*). Lisière herbeuse dans une futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Sericeomyces subvolvatus (Malençon & Bertault) Bon. Plantation pure de *Pinus brutia* à Larissa (Thessalie).

Amanitaceae

Amanita battarae (Boud.) Bon. Futaie pure de *Quercus* spp. au lac de Megdova (Thessalie).

Amanita ceciliae (Berk. & Broome) Bas (= *A. strangulata* = *A. inaurata*). Clairière dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie) ; plantation de *Castanea sativa* au mont Kissavos (Thessalie) ; clairière dans une futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Amanita spissa (Fr.) P. Kumm.. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) ; futaie mixte de *Fagus moesiaca* et de *Castanea sativa* au mont Kissavos (Thessalie).

Amanita submembranacea (Bon) Gröger. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Amanita verna Fr.. Plantation de *Castanea sativa* au mont Kissavos (Thessalie).

Amanita vittadinii Moretti. Sous *Pinus brutia* et dans une prairie à Larissa (Thessalie).

Entolomataceae

Entoloma lividum (Bull.) Fr. (= *E. eulividum*). Futaie pure de *Quercus* spp. au lac de Megdova (Thessalie) ; futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia ; futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Entoloma pseudoturbidum (Romagn.) M. M. Moser. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Entoloma undatum (Fr.) M. M. Moser. Pelouse à côté d'une plantation mixte de *Pinus brutia* et de *Cupressus sempervirens* à Larissa (Thessalie).

Entoloma vernum S. Lundell. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Hygrophoraceae

Hygrocybe spadicea (Scop.) P. Karst.. Clairière herbeuse dans une futaie pure de *Quercus* spp. au lac de Megdova (Thessalie).

Hygrocybe tristis (Pers.) F. H. Møller (= *H. pseudoconica* var. *tristis*). Clairière herbeuse dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie) ; clairière herbeuse dans une futaie pure de *Pinus nigra* à Kerassia (île d'Eubée).

Hygrophorus gliocyclus Fr. (= *H. flavodiscus*). Futaie mixte de *Pinus nigra*, de *Pinus halepensis* et de *Quercus frainetto* à Papades (île d'Eubée).

Hygrophorus latitabundus Britzelm. (= *H. limacinus*). Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Strophariaceae

Panaeolus acuminatus (Schaeff.) Quél. (= *P. caliginosus*). Clairière herbeuse dans une futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Tricholomataceae

Clitocybe catinus Fr.. Futaie pure d'*Abies borisii-regis* à Karpenissi.

Clitocybe costata Kühner & Romagn.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto*, futaie pure de *Quercus* spp. au lac de Megdova (Thessalie) ; futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée) ; plantation de *Pinus nigra* dans une futaie de *Fagus moesiaca* au mont Kissavos (Thessalie).

Clitocybe geotropa (Bull.) Fr.. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Clitocybe langei Singer ex Hora. Futaie pure d'*Abies borisii-regis* à Karpenissi.

Clitocybe umbilicata (Schaeff.) P. Kumm.. Futaie pure d'*Abies borisii-regis* à Karpenissi.

Collybia butyracea var. *asema* Quél.. Plantation de *Pinus nigra* dans une futaie de *Fagus moesiaca* au mont Kissavos (Thessalie).

Collybia extuberans Fr.. Sur souche pourrie dans une futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Collybia maculata (Alb. & Schwein.) Quél.. Futaie pure de *Pinus nigra* à Kerassia (île d'Eubée) et futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Collybia peronata (Bolton) P. Kumm. (= *M. urens*). Futaie mixte de *Fagus moesiaca* et d'*Abies borisii-regis* au mont Kissavos (Thessalie) ; futaie pure de *Quercus* spp., futaie pure et futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Echinoderma carinii (Bres.) Bon. Plantation de *Pinus brutia* à Larissa (Thessalie).

Hohenbuehelia atrocaerulea (Fr.) Singer. Sur tronc de *Platanus orientalis* dans une plantation de *Pinus pinaster* au mont Pélion (Thessalie).

Hohenbuehelia myxotricha (Lév.) Singer. Sur souche pourrie dans une futaie pure d'*Abies borisii-regis* au lac de Megdoba (Thessalie).

Lepista densifolia (J. Favre) Singer & Cléménçon. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée) ; futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdoba (Thessalie).

Lepista sordida var. *lilacea* (Quél.) Bon. Prairie à Larissa.

Lyophyllum leucophaeatum (P. Karst.) P. Karst.. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie) ; plantation de *Pinus brutia* à Larissa (Thessalie).

Lyophyllum transforme (Britzelm.) Singer (= *L. trigonosporum*). Clairière dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Macrocyttidia cucumis (Pers.) Fr.. Futaie pure de *Pinus halepensis* à Vassilika (île d'Eubée).

Marasmius cohaerens (Alb. & Schwein.) Cooke & Quél.. Futaie pure d'*Abies borisii-regis* à Pertouli et au lac de Megdova (Thessalie).

Melanoleuca brevipes (Bull.) Pat.. Prairie à Lazarina (Thessalie).

Melanoleuca decembris Métrod ex Bon. Plantation pure de *Pinus brutia* à Larissa.

Melanoleuca evenosa (Saccardo) Konrad. Endroit herbeux d'une plantation de *Pinus nigra* dans une futaie de *Fagus moesiaca* au mont Kissavos (Thessalie).

Melanoleuca iris Kühner. Prairie à Lazarina (Thessalie).

Melanoleuca meridionalis G. Moreno & Barrasa. Parmi des cistes d'une futaie pure de *Pinus nigra* à Kerassia (île d'Eubée).

Melanoleuca pseudolucina Bon. Pelouse à côté d'une plantation de *Pinus brutia* et de

Cupressus sempervirens à Larissa (Thessalie).

Melanoleuca subpulverulenta (Pers.) Singer. Clairière dans une futaie pure d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Mycena diosma Krieglst. & Schwöbel. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Mycena epipterygia var. *pelliculosa* (Fr.) Maas Geest. (= *M. pelliculosa*). Futaie pure d'*Abies borisii-regis* à Karpenissi et à Pertouli (Thessalie).

Mycena leptcephala (Pers.) Gillet (= *M. chlorinella*). Futaie pure de *Pinus nigra* à Kerassia (île d'Eubée) ; futaie de *Quercus* spp. au lac de Megdova (Thessalie).

Mycena pura f. *alba* (Gillet) Arnolds. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Mycena renati Qué. (= *M. flavipes* = *M. luteoalcalina*). Sous *Arbutus unedo* à Koutsoupia (Thessalie) ; futaie pure de *Quercus frainetto* à Kerassia (île d'Eubée).

Mycena zephirus (Fr.) Qué. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Oudemansiella melanotricha (Dörfelt.) M. M. Moser. Sur bois enfoui dans une futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) ; futaie pure de *Pinus nigra* à Kerassia (île d'Eubée) ; clairière d'une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Pseudoomphalina clusiliformis (Kühner & Romagn.) Bon (= *Collybia clusilis* p.p.). Endroit herbeux dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Tricholoma album (Schaeff.) Fr.. Futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie) ; futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Tricholoma bufonium (Pers.) Fr.. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) et à Karpenissi.

Tricholoma focale (Fr.) Ricken. Futaie mixte de *Pinus nigra*, de *Pinus halepensis* et de *Quercus frainetto* à Papades (île d'Eubée).

Tricholoma fucatum var. *subglobisporum* (Bon) Bon. Parmi des mousses d'une plantation de *Pinus nigra* dans une futaie de *Fagus moesiaca* au mont Kissavos (Thessalie).

Tricholoma myomyces (Pers.) J. E. Lange. Lisière d'une futaie pure de *Pinus nigra* et d'une futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Tricholoma pardinum Qué. (= *T. tigrinum* = *T. pardalotum*). Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Tricholoma pessundatum (Fr.) Qué. Futaie pure d'*Abies borisii-regis* au lac de Megdova et à Pertouli (Thessalie).

Tricholoma pseudoalbum Bon. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Tricholoma pseudonictitans Bon. Futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie) ; futaie mixte de *Pinus nigra*, de *Pinus halepensis* et de *Quercus frainetto* à Papades (île d'Eubée).

Tricholoma saponaceum var. *ardosiacum* Bres.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Tricholoma saponaceum var. *squamosum* (Cooke) Rea. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) et à Karpenissi.

Tricholoma sejunctum var. *coniferarum* Bon. Futaie pure de *Pinus nigra* à Kerassia

(île d'Eubée).

Tricholoma sulphureum* var. *coronarium Pers.. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée); futaie pure d'*Abies borisii-regis* à Karpenissi.

Boletales

Boletaceae

Aureoboletus gentilis (Quél.) Pouzar (= *Pulveroboletus cramesinus*). Clairière dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Boletus fechtneri Velen.. Futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Boletus legalliae Pilát (= *B. splendidus* = *B. satanoides* p.p.). Futaie pure de *Quercus* spp. au lac de Megdova (Thessalie).

Boletus luteocupreus Bertéa & Estadès. Futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Boletus pseudoregius (Hubert) Estadès. Futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Boletus radicans Gillet (= *B. albidus*). Clairière dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Boletus rhodoxanthus (Krombh.) Kallenb.. Futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Leccinum crocipodium (Letell.) Watling (= *L. tessellatum* = *L. nigrescens*). Clairière dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Xerocomaceae

Xerocomus leonis (D. A. Reid) Bon. Futaie pure de *Quercus* spp. et clairière dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Cortinariales

Cortinariaceae

Cortinarius allutus Fr.. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Cortinarius anomalus Fr.. Futaie mixte de *Fagus moesiaca* et d'*Abies borisii-regis* au mont Kissavos (Thessalie); futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Cortinarius anomalus* f. *lepidopus (Cooke) Konrad & Maubl.. Futaie mixte de *Fagus moesiaca* et d'*Abies borisii-regis* au mont Kissavos (Thessalie).

Cortinarius argyrophilus Rob. Henry. Futaie mixte de *Fagus moesiaca* et d'*Abies borisii-regis*; plantation de *Pinus nigra* dans une futaie de *Fagus moesiaca* au mont Kissavos (Thessalie).

Cortinarius bulbosus (Sowerby) Fr.. Futaie pure de *Pinus nigra* à Kerassia (île d'Eubée).

Cortinarius bulliardii (Pers.) Fr.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Cortinarius callisteus Fr.. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Cortinarius calochrous (Pers.) Fr.. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Cortinarius caninus Fr.. Futaie pure et mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Cortinarius claricolor* var. *subturalis Bon & Gaugué (= *C. turmalis* ss. Bres.). Futaie pure d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Cortinarius claricolor* var. *turalis (Fr.) Quadr.. Futaie pure d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Cortinarius claroflavus Rob. Henry. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Cortinarius croceus (Schaeff.) Høil.. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Cortinarius cumatilis Fr.. Futaie pure de *Pinus nigra* à Kerassia (île d'Eubée).

Cortinarius diabolicus Fr.. Futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Cortinarius dibaphus* var. *nemorosus (Rob. Henry) Rob. Henry. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie); futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Cortinarius duracinus* var. *raphanicus Mos.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie) ; futaie mixte de *Fagus moesiaca* et d'*Abies borisii-regis* au mont Kissavos (Thessalie).

Cortinarius elegantior Fr.. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Cortinarius elegantissimus Rob. Henry. Futaie mixte de *Fagus moesiaca* et d'*Abies borisii-regis* au mont Kissavos (Thessalie).

Cortinarius fasciatus Fr.. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie) ; futaie pure de *Pinus nigra* à Kerassia (île d'Eubée).

Cortinarius mairei* var. *juranus Rob. Henry. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Cortinarius melanotus Kalchbr.. Futaie pure d' *Abies borisii-regis* à Pertouli (Thessalie); futaie mixte d' *Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Cortinarius polymorphus Rob. Henry. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Cortinarius prasinocyaneus Rob. Henry. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée) ; futaie pure d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Cortinarius purpurascens* var. *largusoides Cetto. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie) ; futaie pure d'*Abies borisii-regis* à Karpenissi.

Cortinarius riculatus Fr.. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Cortinarius rufo-olivaceus (Pers.) Fr.. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Cortinarius safranopes Rob. Henry. Clairière dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Cortinarius sodagnitus Rob. Henry. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Cortinarius spadiceus Fr.. Futaie mixte de *Fagus moesiaca* et d'*Abies borisii-regis* au mont Kissavos (Thessalie).

Cortinarius suillus Fr.. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Cortinarius turgidus Fr.. Futaie pure d'*Abies borisii-regis* à Pertouli et au lac de Megdova (Thessalie).

Cortinarius venetus var. *venetus* Mos.. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) ; futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Cortinarius violaceus (L.) Fr.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Cortinarius xanthophyllus (Cooke) Rob. Henry. Futaie pure de *Quercus* spp. au lac de Megdova (Thessalie).

Gymnopilus picreus (Pers.) P. Karst. (= *Flammula picrea*). Plantation de *Pinus nigra* dans une futaie de *Fagus moesiaca* au mont Kissavos (Thessalie) ; futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Hebeloma cistophilum Maire. Sous cistes, dans une futaie de *Quercus* spp. au mont Kissavos (Thessalie).

Hebeloma fastibile (Pers.) S. Imai. Futaie pure de *Pinus nigra* à Kerassia (île d'Eubée).

Hebeloma leucosarx P. D. Orton. Futaie de *Quercus* spp. au mont Kissavos (Thessalie), au bord d'un ruisseau.

Inocybe asterospora Quél.. Clairière dans une futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) ; clairière dans une futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Inocybe hirtella Bres.. Futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Inocybe jurana Pat. (= *I. adaequata*). Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Inocybe nitidiuscula (Britzelm.) Lapl. (= *I. friesii*). Plantation pure de *Pinus brutia* et plantation mixte de *Pinus brutia* et de *Cupressus sempervirens* à Larissa (Thessalie).

Inocybe phaeoleuca Kühner. Futaie pure de *Quercus* spp. au lac de Megdova (Thessalie).

Inocybe pudica Kühner. Futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie) ; futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Leucocortinarius bulbiger (Fr.) Singer (= *Cortinellus bulbiger*). Plantation de *Pinus nigra* dans une futaie de *Fagus moesiaca* au mont Kissavos (Thessalie) ; plantation de *Pinus nigra* dans une futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) ; futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) ; futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Gomphales

Ramariaceae

Ramaria flaccida (Fr.) Bourdot. Futaie pure de *Pinus nigra* à Kerassia (île d'Eubée).

Ramaria gracilis (Pers.) Quél.. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Ramaria largentii Marr & D. E. Stuntz. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Hymenochaetales

Hymenochaetaceae

Phellinus lundellii Niemelä. Sur tronc de *Prunus* spp. à Karditsa (Thessalie).

Phellinus vorax (Harkn.) Černý (= *Daedalea vorax*). Sur tronc de pin dans une futaie mixte de *Pinus nigra*, de *Pinus halepensis* et de *Quercus frainetto* à Papades (île d'Eubée).

Poriales

Coriolaceae

Daedaleopsis confragosa (Bolton) J. Schröt. (= *Trametes rubescens*). Sur branches mortes d'*Ailanthus altissima* à Larissa (Thessalie).

Lenzites warnieri Durieu & Mont.. Sur *Populus* spp., dans la plaine de Thessalie.

Trametes ochracea (Pers.) Gilb. & Ryvarden (= *T. multicolor* = *T. zonatella*). Sur tronc tombé de chêne dans une futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Lentinaceae

Pleurotus dryinus (Pers.) Fr. (= *P. corticatus* = *P. tephrotrichus*). Sur tronc de hêtre dans une futaie pure de *Fagus moesiaca* ; sur tronc de hêtre à une plantation de *Pinus nigra* dans une futaie de *Fagus moesiaca* au mont Kissavos (Thessalie).

Polyporaceae

Polyporus melanopus (Pers.) Fr.. Sur bois mort de sapin dans une futaie pure d'*Abies borisii-regis* à Karpenissi.

Russulales

Russulaceae

Lactarius blennius f. *viridis* (Schrad.) Quél. Futaie pure de *Fagus moesiaca* et plantation de *Pinus nigra* dans une futaie de *Fagus moesiaca* au mont Kissavos (Thessalie).

Lactarius camphoratus (Bull.) Fr.. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Lactarius cimararius (Batsch) Gill.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Lactarius fuliginosus Fr.. Futaie de *Quercus* spp. au lac de Megdova (Thessalie).

Lactarius intermedius Krombh.. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Lactarius luridus (Pers.) Fr.. Futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Lactarius pubescens Fr. (= *L. blumii* = *L. cilicioides*). Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Lactarius salmonicolor R. Heim & Leclair. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie) ; futaie pure d'*Abies borisii-regis* à Karpenissi.

Lactarius semisanguifluus R. Heim & Leclair. Futaie pure de *Pinus nigra* à Kerassia (île d'Eubée).

Lactarius sphagnetii (Fr.) M. M. Moser. Dans des sphaignes à une futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Lactarius tesquorum Malençon. Futaie de *Quercus* spp. au mont Kissavos (Thessalie) ; sous des cistes, dans une plantation de *Pinus pinaster* au mont Pélion (Thessalie).

Lactarius uvidus (Fr.) Fr.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Lactarius vinosus Quéll.. Futaie pure de *Pinus nigra* à Kerassia (île d'Eubée).

Russula adulterina Secr.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie) ; futaie pure de *Pinus nigra* à Kerassia (île d'Eubée) ; futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) et à Karpenissi.

Russula amethystina Quéll.. Futaie pure d'*Abies borisii-regis* à Karpenissi ; plantation de *Pinus nigra* dans une futaie d'*Abies borisii-regis* à Pertouli (Thessalie) ; futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée) ; futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Russula amoena Quéll.. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie) ; futaie pure de *Quercus* spp. et futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Russula amoenolens Romagn.. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Russula azurea Bres.. Futaie pure d'*Abies borisii-regis* à Karpenissi ; futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Russula badia Quéll.. Futaie mixte de *Fagus moesiaca* et d'*Abies borisii-regis* au mont Kissavos (Thessalie).

Russula caticata var. *fusca* ss. Melz. & Zv.. Clairière dans une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Russula cyanoxantha var. *pelteaeui* Singer. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Russula densifolia (Secr.) Gillet. Futaie pure d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Russula fageticola (Melzer) S. Lundell (= *R. mairei* v. *fageticola*). Sous hêtre dans une plantation de *Pinus nigra*, dans une futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Russula faginea Romagn.. Plantation de *Castanea sativa* dans une futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Russula farinipes Romell. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Russula graveolens Romell. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Russula illota Romagn.. Futaie pure de *Quercus* spp. au lac de Megdova (Thessalie).

Russula insignis Burl. (= *R. livescens*). Futaie pure d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Russula krombholzii Shaffer (= *R. atropurpurea*). Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Russula langei Bon. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Russula luteotacta Rea. Dans la mousse d'une futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Russula melliolens Quél.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Russula mustelina Fr.. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Russula nana Killerm.. Endroit herbeux d'une futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Russula nauseosa (Pers.) Fr.. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Russula persicina Krombh.. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Russula pseudointegra Arnould & Goris. Futaie mixte de *Quercus* spp. et d'*Abies borisii-regis* à Papades (île d'Eubée).

Russula puellaris Fr.. Futaie pure de *Quercus* spp. au lac de Megdova (Thessalie).

Russula risigallina (Batsch) Sacc. (= *R. lutea* = *R. chamaeleontina*). Futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Russula risigallina* f. *luteorosella (Britzelm.) Bon. Futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Russula romellii Maire. Futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie) ; futaie mixte de *Fagus moesiaca* et d'*Abies borisii-regis* au mont Kissavos (Thessalie) ; futaie pure d'*Abies borisii-regis* à Pertouli (Thessalie).

Russula sphagnophila Kauffman. Dans des sphaignes à une futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Russula vesca Fr.. Plantation de *Castanea sativa* au mont Kissavos (Thessalie).

Russula vesca* f. *viridata Sing.. Plantation de *Castanea sativa* au mont Kissavos (Thessalie).

Russula vinosa Lindblad (= *R. obscura*). Futaie pure d'*Abies borisii-regis* à Karpenissi.

Russula violeipes* f. *citrina Quél.. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Russula viscida Kudřna. Futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Sclerodermatales

Sclerodermataceae

Pisolithus arhizus (Pers.) Rauschert (= *P. tinctorius*). Sous plantules de pin dans une futaie mixte d'*Abies borisii-regis*, de *Pinus nigra* et de *Quercus* spp. à Kerassia (île d'Eubée).

Scleroderma meridionale Demoulin & Malençon. Bord de route d'une futaie mixte d'*Abies borisii-regis* et *Quercus frainetto* au lac de Megdova (Thessalie) ; bord de route d'une futaie pure de *Fagus moesiaca* au mont Kissavos (Thessalie).

Thelephorales

Thelephoraceae

Hydnellum auratile (Britzelm.) Maas Geest.. Futaie mixte d'*Abies borisii-regis* et de *Quercus frainetto* au lac de Megdova (Thessalie).

Hydnellum conrescens (Pers.) Banker (= *H. zonatum*). Futaie de *Quercus* spp. et futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

Sarcodon amarescens (Quél.) Quél. (= *S. glaucopus*). Futaie pure d'*Abies borisii-regis*

à Pertouli (Thessalie).

Sarcodon martioflavus (Snell et al.) Maas Geest.. Futaie mixte de *Quercus frainetto* et d'*Abies borisii-regis* au lac de Megdova (Thessalie).

DISCUSSION ET CONCLUSION

La plupart des espèces présentées dans ce travail, ont été trouvées plusieurs fois, durant le temps des prospections et toutes les caractéristiques qui concernent leur habitat sont en accord avec la bibliographie. Néanmoins, quelques récoltes rares concernant peu d'espèces, comme par exemple *Mycena diosma*, *Cortinarius turgidus*, *Lactarius pubescens* et *Tricholoma pardinum* s'opposent aux données bibliographiques, relativement à leur niche écologique. L'espèce *Mycena diosma* est mentionnée comme inféodée au genre *Fagus*, tandis qu'ici elle est présente sous une futaie mixte de sapin et de chêne. *Cortinarius turgidus* a été trouvé sous une sapinière, tandis qu'il est référé, par Marchand, sous feuillus. *Lactarius pubescens*, inféodé au bouleau, a été trouvé sans cette essence. Enfin *Tricholoma pardinum*, espèce calcicole selon les références bibliographiques, nous l'avons trouvée dans un endroit ayant roche-mère le flysch, qui donne naissance aux sols acides. Nous espérons que nous pourrions éclaircir ces discordances écologiques, par la suite des prospections dans les années suivantes, qui sont déjà en route, aux mêmes sites écologiques.

Quoiqu'il en soit, la conclusion qui sort de ce travail, tenant compte du nombre considérable d'espèces présentées, est que les données sur la mycoflore fongique de la Grèce sont incomplètes. De ce fait, elles sont insuffisantes pour tirer des conclusions en ce qui concerne la rareté ou les menaces de disparition que peuvent subir certaines espèces, à la suite de diverses modifications environnementales (Kapsanaki-Gotsi, 1997). Il devient clair qu'une extension des inventaires à d'autres régions de la Grèce est nécessaire avant d'entreprendre une étude systématique, basée sur des données suffisantes sur la composition et la structure des communautés fongiques.

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AN INDEX TO BATSCH'S
ELENCHUS FUNGORUM, 1783-89

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ABSTRACT

The taxa described and illustrated in the 3 volumes of Batsch's *Elenchus Fungorum* are fully indexed, and all references to these taxa in the sanctioning works of Persoon and Fries, and in Fries's *Hymenomyces Europaei*, are listed. **KEYWORDS:** nomenclature, sanctioned names

INTRODUCTION

August Johann Georg Carl Batsch (1761-1802) was a German botanist and professor at Jena. His major, and only, contribution to mycological literature was the *Elenchus Fungorum* (Batsch 1783) and its two *Continuatio* volumes (Batsch 1786, 1789). The pagination of these three volumes is intriguing. The 25 × 21 cm pages are unnumbered, but each contains two columns of parallel text, one in Latin and the other in German, and these columns are numbered consecutively throughout the volume. Thus the Latin text occupies the odd-numbered columns, and the German text the even-numbered. Consequently, all nomenclatural citations must refer to odd-numbered columns, because only they contain Latin binomials. The illustrations are printed from 23 × 18.5 cm plates engraved and coloured from Batsch's original paintings; the habit studies are very lifelike and demonstrate sufficient detail to enable determination at the macroscopic level.

The layout of the initial volume (Batsch 1783) is complex. There are five major sections — *Praefatio* (the preface); *Synopsis Fungorum* (synopses of orders and genera); *Subordines Species* (the nomenclature, figure references, and basic descriptions of the taxa); *Annotationes* (descriptive material pertaining to the illustrated collections, including details of habitat, substrate, and time of year); and *Icones Fungorum Nonnullorum Agri Jenensis* (the coloured plates). The *Subordines Species* section describes 283 fungal species (plus numerous varieties) in 9 genera — *Agaricus*, *Boletus*, *Clathrus*, *Clavaria*, *Hydnum*, *Lycoperdon*, *Mucor*, *Peziza*, and *Phallus*. These taxa are numbered in a hierarchical system, with the genera enumerated by Roman numerals, the species within each genus by Arabic numerals, and the (un-named) varieties within a species by Greek letters. Most of the taxa are referred to one or more previously published illustrations, particularly those of Schaeffer (1762-74) and Micheli (1729); however, 57 taxa (i.e. about a fifth of the species) are referred to "Ic. jen.", i.e. to the 12 plates of Batsch's figures (Tab. 1-12, Fig. 1-57) that are annexed to the volume. The *Annotationes* section deals only with those taxa that are

illustrated in Batsch's "*Ic. jen.*" Each paragraph is headed somewhat cryptically with a Roman numeral, followed by an abbreviated genus name and an Arabic numeral, but no specific epithet, making it difficult to ascertain the corresponding taxonomic treatment in the *Subordines Species* section. In fact, the Roman numeral is the number of the relevant figure in the annexed "*Ic. jen.*" plates, and the Arabic numeral is the number of the relevant species in the hierarchical numbering system of the *Subordines Species* section.

The two *Continuatio* volumes add 143 species and 15 varieties, and a further 4 genera — *Elvela* [= *Helvella*], *Embolus*, *Sphaeria*, and *Stemonitis* — as well as revisiting 17 taxa (and recombining one of them) from the initial volume. Six of the varieties have varietal epithets, in addition to the Greek letters by which most varieties are designated throughout the three volumes. Every taxon in the *Continuatio* volumes is illustrated in 30 plates of figures (Tab. 13–42, Fig. 59–232). In contrast to the complex layout of the initial volume, the *Continuatio* volumes have a single comprehensive text entry for each taxon. The numbering of these text entries (59–232) corresponds exactly to the numbering of the relevant figures; it is thus a continuation of the numbering of the initial volume's *Annotationes* section, but has no relationship with the hierarchical numbering system of the initial volume's *Subordines Species* section.

The importance of Batsch's opus is indicated by the number of his epithets that were accepted in the sanctioning works of Persoon and Fries, and in Fries's later publications. Accurate citation of these epithets can be a problem. Fries's citations are not to be relied on, since they are often mistranscribed, or are ambiguous as to which of Batsch's three volumes is involved, or cite a figure/taxon number rather than a "page" [= column] number. (The establishment of an accurate citation is not a mere exercise in pedantry! Widespread practice notwithstanding, a citation attributing publication of a pre-Friesian name to the page in the sanctioning works on which it was taken up by Fries is no substitute for the citation of the original point of valid publication. It is, for example, the date of the original valid publication that determines priority between competing sanctioned names.) Laplanche (1894, pp. 354–361) gives a useful "Tableau de Concordance de Batsch", but this includes only the hymenomycetous subset of Batsch's figures and makes no reference to the text. Batsch's volumes themselves are not widely available for consultation, and I am not aware of any easily accessible index to them. The INDEX below has been compiled to fill this gap. All the specific and varietal epithets from Batsch's three volumes are listed in a single alphabetic sequence, with: (i) Batsch's generic placement of the epithet; (ii) the taxonomic "page" [= column] citation for the taxon, together with the "page" reference (in parenthesis) of any additional text; (iii) the plate+figure citation(s) for the taxon; (iv) reference(s) to the taxon in the Persoonian sanctioning work (Persoon 1801); (v) reference(s) to the taxon in the Friesian sanctioning works (Fries 1821, 1822–23, 1828a, 1828b, 1829–32, 1832); and (vi) reference(s) to the taxon in a later Friesian work (Fries 1874). Substitution of *Helvella* for *Elvela*, and minor alterations to Batsch's original spelling (in accordance with ICBN's instructions for grammatical corrections) have been incorporated without comment.

SANCTIONED AND ACCEPTED EPITHETS

A total of 70 of Batsch's names were sanctioned, by being accepted either directly, or in a different genus, or at a different rank. These names are in **bold type** in the INDEX, below.

Persoon sanctioned 5 of Batsch's names — *Lycoperdon giganteum*, *L. pusillum* (as *Bovista*), *L. fenestratum* var. β (as *Geastrum quadrifidum* γ *fenestratum*), *Lycoperdon furfuraceum* (as *Bovista*), and *Peziza olla* (as *Cyathus*). The first three are sanctioned explicitly, the fourth and fifth by implication. Although Persoon attributed *L. furfuraceum* to Gmelin, Batsch's earlier taxon of the same name is stated (Fries 1829–32, De Toni 1888, sub *Bovista plumbea*) to be synonymous. Similarly, although Persoon did not attribute the epithet *olla* to any previous author, Fries synonymised both *Cyathus olla* and *Peziza olla* with *Nidularia campanulata* (Fries 1822–23, 1832, respectively), and Brodie (1971) attributed the basionym of Persoon's name to Batsch.

Fries sanctioned 65 of Batsch's names. These include 2 names that Fries accepted but mistranscribed — *Agaricus violaceofulvens* (as *A. violaceofulvus*), and *Peziza cupressi* (as *P. cupressina*) — and 7 names that were sanctioned at a different rank — *Agaricus candidus* (as *A. geophyllus* β [*candidus*]), *Agaricus saccharinus* (as *A. pterigenus* β *saccharinus*), *Agaricus sphinx* (as *A. velutipes* β *sphinx*), *Hydnum suberosum* var. β *aurantiacum* (as *Hydnum aurantiacum*); *Peziza convivalis* (as *P. cyathoidea* β *convivalis*), *Peziza infundibulum* (as *P. calyculus* β *infundibulum*), and *Sphaeria acinosa* (as *S. hirsuta* β *acinosa*).

Many other of Batsch's names were also accepted in the sanctioning works, but fall outside the sanctioning canon, e.g., Myxomycete names accepted by either Persoon or Fries, and Gasteromycete names accepted by Fries. (N.B. *Phallus gigas* and *P. undosus* were accepted by Fries in the Ascomycete genus *Morchella*, and therefore are sanctioned; whereas *Peziza nutans* was accepted by Fries in the Myxomycete genus *Craterium*, and therefore is not sanctioned.) A large proportion of the remaining names were placed in synonymy in the sanctioning works, but many of these were accepted subsequently as good species in Fries's later publications.

Attention must be drawn to four further names mistranscribed by Fries — *Agaricus digitalis* (as *A. digitellus*), *Agaricus fritillarius* (as *A. frittilarius*), *Lycoperdon arrhizon* (as *L. arrhizum*), and *Lycoperdon polyrhizon* (as *L. polyrhizum*) — and to one mistranscribed by both Persoon and Fries — *Agaricus laterinus* (as *A. lateritius*). The latter error is particularly confusing, because Batsch used both these epithets, one for a *Cortinarius*, the other for a *Hebeloma*. He referred his *A. lateritius* to two Schaeffer illustrations, T.42 [= *Cortinarius varius* (Schaeff.:Fr.) Fr.] and T.54 [= *Cortinarius ochroleucus* (Schaeff.:Fr.) Fr.]. When Persoon (1801) and Fries (1821) synonymised "*A. lateritius* Batsch f.195" with *A. fastibilis* [= *Hebeloma fastibile* (Pers.:Fr.) Fr.], they clearly intended *A. laterinus* Batsch, since that is the taxon illustrated in the figure they both cited. Fries (1832) went some way towards correcting the error, by explicitly synonymising *A. laterinus* Batsch with *A. fastibilis*, while failing to contradict the erroneous synonymy of *A. lateritius* Batsch.

Other potential sources of confusion are taxa for which Fries, in at least one reference, substituted a different epithet (or genus) while still attributing the name to Batsch — *Agaricus hypni* (as *A. hypnorum*), *Agaricus ochraceus* (as *Cortinarius isabellinus*), *Agaricus serpentiformis* (as *Helvella serpentiformis*), *Agaricus subantiquatus* (as *A. cristatus*), *Agaricus subhepaticus* (as *A. hepaticus*), *Agaricus subtestaceus* (as *A. testaceus*), *Helvella sepulchralis* (as *Embolus sepulchralis*), *Hydnum hystricinum* (as *H. hystrix*), *Hydnum pectiniforme* (as *H. orbiculatum*), *Lycoperdon palmiforme* (as *L. palmatum*), *Peziza nutans* β (as *P. cernua* β), *Peziza tuba* (as *P. tubaeformis*), and *Phallus fungoides* (as *P. lobatus*).

The INDEX includes all references to Batsch's names that occur in the specified works of Persoon and Fries, with the exception of index references that contribute no additional information. Some of the references are indirect, via figure/taxon numbers rather than the names themselves. References in which Batsch's epithet is sanctioned or accepted are in **bold type**. References that involve the erroneous names detailed above are enclosed in [square brackets]; as are also the references of the two implied Persoonian sanctionings, detailed above.

ANOMALOUS NAMES

Unaccountably, Batsch used the same name, *Agaricus fulvens*, for two different taxa. He referred them to different Schaeffer illustrations, one to T.5 [= a *Lactarius*], the other to T.245 [= an *Amanita*]. In the INDEX, these two taxa are differentiated by their Schaeffer references. Batsch published one illustration (t.12 f.58) of a fungus for which he provided no formal name. This taxon is included in the INDEX under [*roseus*, *Aspergillus*], the name subsequently applied to it by Fries (1829–32).

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 Micheli, P.A. 1729. *Nova Plantarum Genera*. Firenze.
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INDEX TO BATSCH'S *ELENCHUS FUNGORUM*

Abbreviations:	E = Batsch (1783)	SMF = Persoon (1801)	SM1 = Fries (1821)
	C1 = Batsch (1786)		SM2 = Fries (1822-23)
	C2 = Batsch (1789)		EF1 = Fries (1828a)
			SM3 = Fries (1829-32)
			IA = Fries (1832)
			HE = Fries (1874)

Bold taxon = sanctioned name.

Bold reference = Batsch's name accepted.
[Bracketed reference] = erroneous name cited.

Taxon	Page citation	Figure citation	Persoon (1801)	Fries (1821-32)	Fries (1874)
<i>abietis</i> , <i>Agaricus</i>	E:73 (163)	t.3 f.10	...	SM1:139	HE:478
<i>acaulis</i> , <i>Phallus</i>	E:129	...	...	SM2:33	...
<i>acinosa</i> , <i>Sphaeria</i>	C1:269	t.30 f.179	SMF:73	SM2:450	...
<i>acuminatus</i> , <i>Phallus</i>	E:133	...	...	...	...
<i>adiposus</i> , <i>Agaricus</i>	C1:147	t.22 f.113	...	SM1:242	HE:222
<i>admorsum</i> , <i>Lycoperdon</i>	E:149	...	...	...	...
<i>adnatus</i> , <i>Clathrus</i>	E:141	...	...	...	...
<i>adustus</i> , <i>Agaricus</i>	E:67	...	...	...	...
<i>aethiops</i> , <i>Agaricus</i>	E:71	...	...	...	...
<i>alneus</i> , <i>Agaricus</i>	E:95	...	...	...	...
<i>alutaceus</i> , <i>Agaricus</i>	C1:163	t.23 f.119	...	IA:6	HE:198
<i>amanitae</i> , <i>Agaricus</i>	C1:109	t.18 f.93	SMF:374	SM1:133	HE:119
<i>amenti</i> , <i>Peziza</i>	C1:211	t.27 f.148	SMF:669	SM2:127	...
<i>anastomosis</i> , <i>Phallus</i>	E:131	...	...	SM2:9	...
<i>angulatus</i> , <i>Agaricus</i>	E:73	...	...	SM1:140, IA:7	...
<i>annularis</i> , <i>Peziza</i>	C1:201	t.26 f.139	...	SM2:137, 306	...
<i>antiquata</i> , <i>Peziza</i>	E:119 (C1:203)	t.27 f.141	...	...	...
<i>antiquatus</i> , <i>Agaricus</i>	E:55	...	...	SM1:20	...
<i>applicatus</i> , <i>Agaricus</i>	C1:171	t.24 f.125	SMF:484	SM1:192	HE:180
<i>aquamarinus</i> , <i>Agaricus</i>	E:51	...	...	...	...
<i>aqueus</i> , <i>Agaricus</i>	E:61	...	...	...	...
<i>arcularius</i> , <i>Boletus</i>	E:97	...	SMF:518	SM1:342	HE:526
<i>arrhizon</i> , <i>Lycoperdon</i>	C1:239	t.29 f.166	SMF:137	SM3:23 [IA:110]	...
<i>asperus</i> , <i>Agaricus</i>	E:73	...	...	...	...
<i>asserculorum</i> , <i>Agaricus</i>	E:95	...	SMF:487	SM1:334, IA:8	...
<i>ater</i> , <i>Mucor</i>	E:157	...	...	...	...
<i>atricapillus</i> , <i>Agaricus</i>	C1:77	t.16 f.76	...	SM1:199	HE:185
<i>atrocyaneus</i> , <i>Agaricus</i>	C1:101	t.18 f.87	SMF:378	SM1:147	HE:141
<i>atropurpurea</i> , <i>Clavaria</i>	E:133 (179)	t.11 f.47	SMF:609	SM1:490	...
<i>atrosquamosus</i> , <i>Agaricus</i>	E:81 (171)	t.6 f.27	...	IA:8	...
<i>atrotomentosus</i> , <i>Agaricus</i>	E:89 (173)	t.8 f.32	SMF:473	SM1:272	HE:403
<i>aurantiacum</i> , <i>Hydnum</i>					
<i>suberosum</i> var. β	C2:103	t.40 f.222	SMF:xxx	SM1:403, 516	...
<i>aurantius</i> , <i>Agaricus</i>	E:45	...	...	...	...
<i>aurantius</i> var. α , <i>Agaricus</i>	E:45	...	...	SM1:42	...
<i>aurantius</i> var. β , <i>Agaricus</i>	E:45	...	...	...	...
<i>aurantius</i> var. γ , <i>Agaricus</i>	E:45	...	...	...	...
<i>aureus</i> , <i>Agaricus</i>	E:57	...	...	SM1:15	...
<i>auricomus</i> , <i>Agaricus</i>	E:75 (167)	t.5 f.21	...	SM1:259	HE:233

Taxon	Page citation	Figure citation	Persoon (1801)	Fries (1821-32)	Fries (1874)
<i>auricula</i> , Peziza	E:117	...	...	...	...
<i>auriscalpium</i> , Hydnum	E:111	...	...	...	...
<i>aurivellus</i> , Agaricus	C1:153	t.22 f.115	SMF:269	SM1:242	HE:220
<i>aurivenius</i> , Agaricus	C1:137	t.20 f.107	SMF:310	SM1:258	HE:232
<i>auroa</i> , Agaricus	E:93 (175)	t.9 f.36	...	SM1:320	...
<i>auroa</i> var. α , Agaricus	E:93	...	...	...	...
<i>auroa</i> var. β , Agaricus	E:93 (175)	t.9 f.36	...	...	...
<i>balanus</i> , Agaricus	E:63	...	...	...	...
<i>barbatus</i> , Agaricus	E:39 (163)	t.3 f.11	...	SM1:237	HE:351
<i>beryllus</i> , Agaricus	E:83 (C2:83)	t.38 f.213	SMF:419	SM1:286	HE:284
<i>bicolor</i> , Agaricus	E:95	...	...	...	...
<i>bolaris</i> , Peziza	C1:221	t.28 f.155	SMF:658	SM2:112	...
<i>boletiforme</i> , Lycoperdon	E:149	...	...	...	...
<i>bombacinum</i> , Lycoperdon	E:153	...	...	SM3:184	...
<i>bombarda</i> , Sphaeria	C1:271	t.30 f.181	SMF:76	SM2:456	...
<i>bovinus</i> , Boletus	E:99	...	...	IA:56	...
<i>brachiata</i> , Clavaria	C1:233	t.28 f.163	SMF:688	SM3:279	...
<i>brunnea</i> , Peziza	E:125 (181)	t.11 f.50	...	SM2:167	...
<i>brunneus</i> , Phallus	E:129	...	...	...	...
<i>buccinalis</i> , Agaricus	C2:85	t.39 f.214	...	SM1:163	HE:159
<i>bulbularis</i> , Agaricus	C1:137	t.21 f.108	...	SM1:283	HE:260
<i>caesius</i> , Agaricus	C1:113	t.18 f.94	...	IA:10	HE:152
<i>callosa</i> , Peziza	C2:95	t.39 f.219	...	...	...
<i>calyciformis</i> , Helvella	C1:195	t.26 f.135	...	SM2:91	...
<i>calyculus</i> , Peziza	E:123 (181)	t.12 f.57	SMF:660	SM2:118	...
<i>calyculus</i> var. α , Peziza	E:123	...	...	...	...
<i>calyculus</i> var. β , Peziza	E:123	...	...	...	...
<i>calyculus</i> var. γ , Peziza	E:123 (181)	t.12 f.57	SMF:660	...	...
<i>campanella</i> , Agaricus	E:73	...	SMF:470	SM1:166	HE:162
<i>cancellatus</i> , Clathrus	E:141	...	...	...	...
<i>cancellatus</i> , Mucor	C2:135	t.42 f.232	SMF:190	SM3:165	...
<i>candidus</i> , Agaricus	C1:133	t.20 f.106	SMF:287	SM1:259	HE:235
<i>canescens</i> , Agaricus	E:95 (175)	t.9 f.38	...	SM1:274	...
<i>canobrunneus</i> , Agaricus	C1:133	t.20 f.105	...	SM1:294	...
<i>cantharellus</i> , Agaricus	E:95 (175)	t.9 f.34	...	SM1:330, EF1:50	...
<i>canus</i> , Boletus	E:101	...	...	...	...
<i>canus</i> var. α , Boletus	E:101	...	...	...	...
<i>canus</i> var. β , Boletus	E:101	...	...	...	...
<i>capitatum</i> , Lycoperdon	E:147	...	...	SM3:53	...
<i>carbonarius</i> , Agaricus	E:69 (161)	t.2 f.6	SMF:411	SM1:301	HE:311
<i>carbonarius</i> var. α , Agaricus	E:69	...	...	...	...
<i>carbonarius</i> var. β , Agaricus	E:69	...	...	...	...
<i>carbonarius</i> var. γ , Agaricus	E:69 (161)	t.2 f.6	...	...	...
<i>carbonarius</i> var. δ , Agaricus	C1:107	t.18 f.91	SMF:411	SM1:298	HE:310
<i>carneolus</i> , Agaricus	E:83	...	...	IA:11	...
<i>carneotomentosus</i> , Agaricus	E:89 (173)	t.8 f.33	SMF:475	SM1:181, IA:11	HE:489
<i>carneotomentosus</i> var. α , Agaricus	E:91 (173)	t.8 f.33	...	...	...
<i>carneotomentosus</i> var. β , Agaricus	E:91	...	...	...	...
<i>carnosum</i> , Hydnum	E:111 (C1:197)	t.26 f.136	...	SM1:400	...
<i>carpini</i> , Peziza	C1:215	t.27 f.150	...	SM2:118	...

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<i>carpobolus</i> , <i>Lycoperdon</i>	E:153	...	SMF:115	SM2:310	...
<i>caryophyllatus</i> , <i>Agaricus</i>	E:75	...	...	IA:11	...
<i>castaneus</i> , <i>Agaricus</i>	E:49	...	...	...	...
<i>cepiforme</i> , <i>Lycoperdon</i>	E:147	...	...	SM3:46	...
<i>ceraceus</i> , <i>Agaricus</i>	E:41	...	...	SM1:249	...
<i>cervinum</i> , <i>Lycoperdon</i>	E:143	...	...	...	...
<i>chalybeum</i> , <i>Lycoperdon</i>	E:155	...	...	...	...
<i>chamaeleo</i> , <i>Agaricus</i>	E:63	...	...	...	...
<i>chrysodon</i>, <i>Agaricus</i>	C2:79	t.38 f.212	SMF:365	SM1:32	HE:405
<i>chrysolithus</i> , <i>Agaricus</i>	E:81	...	...	...	...
<i>cimicarius</i> , <i>Agaricus</i>	C1:59	t.15 f.69	SMF:434	SM1:70	HE:437
<i>cinctus</i> , <i>Agaricus</i>	E:69	...	...	...	...
<i>cinerascens</i> , <i>Agaricus</i>	C1:125	t.19 f.101	...	SM1:171	HE:100
<i>cinerea</i>, <i>Peziza</i>	C1:197	t.26 f.137	SMF:634	SM2:142	...
<i>cinereorimosus</i> , <i>Agaricus</i>	C2:63	t.37 f.206	SMF:xxxix	SM1:116	HE:61
<i>cinereum</i> , <i>Hydnum</i>					
<i>suberosum</i> var. γ		C2:107 t.40 f.223	SMF:xxx	SM1:404	...
<i>cinereum</i> , <i>Lycoperdon</i>	E:155 (C1:249)	t.29 f.169	SMF:170	SM3:126	...
<i>cinereus</i> , <i>Agaricus</i>	E:93	...	...	...	...
<i>circumscissum</i> , <i>Lycoperdon</i>	E:145	...	...	SM3:29	...
<i>circumscissum</i> var. α , <i>Lycoperdon</i>	E:145	...	...	...	...
<i>circumscissum</i> var. β , <i>Lycoperdon</i>	E:145	...	...	...	...
<i>circumscissum</i> var. γ , <i>Lycoperdon</i>	E:145	...	...	...	...
<i>circumscissum</i> var. δ , <i>Lycoperdon</i>	E:145	...	...	...	...
<i>circumseptus</i> , <i>Agaricus</i>	C1:119	t.19 f.98	...	SM1:266	HE:273
<i>citrina</i>, <i>Peziza</i>		C2:95 t.39 f.218	...	SM2:131, 609	...
<i>clandestinum</i> , <i>Hydnum</i>	E:113 (177)	t.10 f.44	...	SM1:400	...
<i>clavatus</i> , <i>Agaricus</i>	E:55	...	...	SM1:25, IA:13	...
<i>clavularis</i> , <i>Agaricus</i>	C1:89	t.17 f.81	...	SM1:159	HE:151
<i>clavus</i> , <i>Agaricus</i>	C2:41	t.35 f.199	...	SM1:249	HE:239
<i>cochleata</i> , <i>Peziza</i>	E:117	...	...	...	...
<i>cochleata</i> var. α , <i>Peziza</i>	E:117 (C1:225)	t.28 f.158	...	...	...
<i>cochleata</i> var. β , <i>Peziza</i>	E:117 (C1:223)	t.28 f.157	SMF:646	SM2:49, 55	...
<i>cochleata</i> var. γ , <i>Peziza</i>	E:117	...	...	...	...
<i>comitalis</i> , <i>Peziza</i>	C1:217	t.27 f.152	...	SM2:577	...
<i>complanatum</i> , <i>Lycoperdon</i>	C1:251	t.29 f.170	SMF:170	SM3:126	...
<i>conchiformis</i> , <i>Boletus</i>					
<i>suberosus</i> var. β		C2:121 t.41 f.227	SMF:529	SM1:363	...
<i>convivalis</i>, <i>Peziza</i>	E:121	...	...	SM2:124, SM3:153	...
<i>coralloideum</i> , <i>Hydnum</i>	E:113	...	...	...	...
<i>coriaceus</i> , <i>Agaricus</i>	C1:139	t.21 f.109	...	SM1:129	HE:468
<i>coriaceus</i> , <i>Boletus</i>	E:105 (C1:177)	t.24 f.127	...	SM1:371, IA:57	...
<i>cornea</i>, <i>Clavaria</i>	E:139 (C1:229)	t.28 f.161	SMF:596	SM1:486	HE:680
<i>cornu-alces</i> , <i>Clavaria</i>	E:135	...	SMF:595	...	...
<i>cornu-cervi</i> , <i>Clavaria</i>	E:135	...	...	...	...
<i>corollinum</i> , <i>Lycoperdon</i>	E:151	...	...	SM3:17	...
<i>coronata</i> , <i>Peziza</i>	E:119	...	SMF:636	SM2:52	...
<i>corticale</i> , <i>Lycoperdon</i>	E:155	...	...	SM3:191	...
<i>corticalis</i>, <i>Clavaria</i>	C1:231	t.28 f.162	...	EF1:233	...
<i>coryli</i>, <i>Sphaeria</i>	C2:131	t.42 f.231	SMF:36	SM2:436	...
<i>costatus</i> , <i>Phallus</i>	E:129	...	...	...	...
<i>costatus</i> var. α , <i>Phallus</i>	E:129	...	...	...	...

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<i>costatus</i> var. β , <i>Phallus</i>	E:131	...	...	...	...
<i>costatus</i> var. γ , <i>Phallus</i>	E:131	...	...	...	...
<i>crater</i> , <i>Peziza</i>	E:125	...	...	...	...
<i>crenulatus</i> , <i>Agaricus</i>	E:71	...	...	...	...
<i>crispus</i> , <i>Agaricus</i>	E:67	...	...	...	...
<i>crispus</i> , <i>Boletus</i>	E:103	...	...	...	...
<i>crocatu</i> s, <i>Agaricus</i>	E:71	...	...	...	...
<i>crocatu</i> s, <i>Boletus nitens</i> var. ζ	C2:113	t.41 f.225	...	SM1:353	...
<i>crocatu</i> s, <i>Embolus</i>	C1:265	t.30 f.177	...	SM3:177	...
<i>crucibulum</i>, <i>Peziza</i>	E:119	...	SMF:642	SM2:53	...
<i>cucullata</i>, <i>Helvella</i>	C1:189	t.26 f.132	SMF:611	SM1:493, EF1:233	...
<i>cupressi</i>, <i>Peziza</i>	E:119	...	...	SM2:135, 610	...
<i>cupula</i> , <i>Peziza</i>	E:127	...	...	...	...
<i>cyanophallu</i> s, <i>Agaricus</i>	C1:97	t.17 f.85	SMF:378	SM1:146	...
<i>cyprin</i> us, <i>Agaricus</i>	E:57	...	...	...	...
<i>dealbatus</i> , <i>Agaricus</i>	E:75	...	...	...	...
<i>defossum</i> , <i>Lycoperdon</i>	C2:125	t.42 f.229	SMF:153	SM3:48	...
<i>defossu</i> s, <i>Agaricus</i>	C1:69	t.15 f.73	...	SM1:223	HE:344
<i>delicatu</i> s, <i>Agaricus</i>	E:43	...	...	...	...
<i>delicatu</i> s var. α , <i>Agaricus</i>	E:43	...	...	...	...
<i>delicatu</i> s var. β , <i>Agaricus</i>	E:43	...	...	...	...
<i>delicatu</i> s var. γ , <i>Agaricus</i>	E:43	...	...	...	...
<i>deliciosu</i> s, <i>Agaricus</i>	E:41	...	...	...	...
<i>deliciosu</i> s var. α , <i>Agaricus</i>	E:41	...	...	...	...
<i>deliciosu</i> s var. β , <i>Agaricus</i>	E:41	...	...	...	...
<i>deliciosu</i> s var. γ , <i>Agaricus</i>	E:41	...	...	...	...
<i>deliciosu</i> s var. δ , <i>Agaricus</i>	E:41	...	...	...	...
<i>deliciosu</i> s var. ϵ , <i>Agaricus</i>	E:41	...	...	...	...
<i>deliciosu</i> s var. ζ , <i>Agaricus</i>	E:41	...	...	SM1:62	...
<i>deliciosu</i> s var. η , <i>Agaricus</i>	E:43	...	...	...	...
<i>deliciosu</i> s var., <i>Agaricus</i>	C1:57	t.14 f.68	SMF:437	SM1:65	HE:428
<i>denudatu</i> s, <i>Agaricus</i>	E:53	...	...	...	...
<i>depluens</i>, <i>Agaricus</i>	C1:167	t.24 f.122	SMF:484	SM1:275	HE:214
<i>diadema</i> , <i>Peziza</i>	E:119	...	...	...	...
<i>diffusu</i> s, <i>Agaricus</i>	C1:143	t.21 f.111	SMF:425	SM1:299	HE:318
<i>digitalis</i> , <i>Agaricus</i>	E:61 (159)	t.1 f.1	...	SM1:310	HE:327
<i>digitata</i> , <i>Clavaria</i>	E:137	...	...	...	...
<i>discors</i> , <i>Agaricus</i>	C2:31	t.34 f.196	SMF:351	SM1:34, IA:17	HE:411
<i>dispar</i> , <i>Agaricus</i>	C2:75	t.38 f.210	SMF:368	SM1:123, IA:17	HE:471
<i>dispar</i> , <i>Lycoperdon</i>	E:147	...	...	SM3:49	...
<i>dubia</i> , <i>Peziza</i>	C1:209	t.27 f.145	...	SM2:138	...
<i>echinu</i> s, <i>Lycoperdon</i>	E:145	...	...	...	...
<i>elatus</i>, <i>Agaricus</i>	C2:11	t.32 f.188	SMF:332	SM1:248	HE:241
<i>elvela</i> , <i>Boletus</i>	E:105	...	...	...	...
<i>eruciformis</i>, <i>Peziza</i>	E:125	...	...	SM2:203, IA:131	...
<i>fastigiata</i> , <i>Clavaria</i>	E:137 (179)	t.11 f.48	...	SM1:467	HE:671
<i>fastigiata</i> var. α , <i>Clavaria</i>	E:137	...	...	...	...
<i>fastigiata</i> var. β , <i>Clavaria</i>	E:137 (179)	t.11 f.48	...	...	...
<i>fastigiata</i> var. γ , <i>Clavaria</i>	E:137	...	...	...	...

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<i>favogineum</i> , <i>Lycoperdon</i>	C1:257	t.30 f.173	SMF:181	SM3:187	...
<i>favus</i> , <i>Boletus</i>	E:97	...	...	...	...
<i>fenestratum</i> , <i>Lycoperdon</i>	E:151	...	...	...	...
<i>fenestratum</i> var. α , <i>Lycoperdon</i>	E:151	...	...	...	...
<i>fenestratum</i> var. β et γ , <i>Lycoperdon</i>	C1:243	t.29 f.168	...	SM3:12	...
<i>fenestratum</i> var. β, <i>Lycoperdon</i>	E:151 (C1:245)	t.29 f.168	SMF:134	...	...
<i>fenestratum</i> var. γ , <i>Lycoperdon</i>	C1:247	t.29 f.168	SMF:134	...	...
<i>ferruginascens</i> , <i>Agaricus</i>	C2:9	t.32 f.187	...	SM1:226, IA:19	HE:340
<i>ferruginatus</i> , <i>Agaricus</i>	C1:109	t.18 f.92	...	SM1:107	...
<i>ferruginatus</i> , <i>Boletus</i>	C1:179	t.25 f.128	SMF:508	SM1:388	HE:500
<i>ferrugineus</i> , <i>Agaricus</i>	E:85	...	...	...	...
<i>ferruginosa</i> , <i>Stemonitis</i>	C1:261	t.30 f.175	SMF:198	SM3:195	...
<i>fibrillosus</i> , <i>Agaricus</i>	E:71	...	...	...	...
<i>fimbriatus</i> , <i>Agaricus</i>	E:53	...	...	...	...
<i>flabellaris</i>, <i>Clavaria</i>	C1:227	t.28 f.159	SMF:584	SM1:433 , EF1:166	HE:634
<i>flabelliformis</i> , <i>Boletus</i>					
<i>suberosus</i> var. α	C2:117	t.41 f.226	...	SM1:363	...
<i>flammans</i>, <i>Agaricus</i>	E:87 (173)	t.7 f.30	...	SM1:244	HE:220
<i>flavens</i> , <i>Agaricus</i>	E:75	...	...	...	...
<i>flavofloccosus</i> , <i>Agaricus</i>	C1:117	t.19 f.97	SMF:264	SM1:24	HE:37
<i>floccosa</i> , <i>Peziza</i>	C1:223	t.28 f.156	...	...	...
<i>floccosus</i> , <i>Agaricus</i>	E:87	...	...	IA:20	...
<i>floribundus</i> , <i>Boletus</i>	E:107	...	...	...	...
<i>flurstedtiensis</i> , <i>Agaricus</i>	C1:171	t.24 f.124	...	SM1:274	HE:276
<i>fragilis</i>, <i>Agaricus</i>	C2:87	t.39 f.215	SMF:455	SM1:269 , EF1:36, IA:20	...
<i>fritillarius</i> , <i>Agaricus</i>	E:49	...	...	SM1:53, IA:21	...
<i>fruticulosa</i> , <i>Clavaria</i>	E:137	...	...	IA:73	...
<i>fuliginarius</i> , <i>Agaricus</i>	E:71 (177)	t.9 f.40	...	SM1:146, IA:21	...
<i>fuliginatus</i> , <i>Agaricus</i>	E:81 (171)	t.6 f.26	...	SM1:200	...
<i>fulvens</i> , <i>Agaricus</i> ["Sch. V"]	E:43	...	...	...	...
<i>fulvens</i> , <i>Agaricus</i> ["Sch. CCXLV"]	E:51	...	...	...	...
<i>fungites</i> , <i>Agaricus</i>	E:51	...	...	...	...
<i>fungites</i> var. α , <i>Agaricus</i>	E:51	...	...	...	...
<i>fungites</i> var. β , <i>Agaricus</i>	E:51	...	...	...	...
<i>fungites</i> var. γ , <i>Agaricus</i>	C1:85	t.17 f.79	...	SM1:14	HE:27
<i>fungoides</i> , <i>Phallus</i>	E:129	...	...	[SM2:14, IA:141]	...
<i>furfuraceum</i>, <i>Lycoperdon</i>	E:145	...	[SMF:138]	SM3:24	...
<i>furfuraceus</i> , <i>Mucor</i>	E:157 (C1:267)	t.30 f.178	...	...	...
<i>furnus</i> , <i>Agaricus</i>	E:69	...	...	...	...
<i>furnus</i> var. α , <i>Agaricus</i>	E:69	...	...	...	...
<i>furnus</i> var. β , <i>Agaricus</i>	E:69	...	...	...	...
<i>fuscescens</i> , <i>Agaricus</i>	E:77	...	...	...	...
<i>fuscus</i> , <i>Agaricus</i>	E:47	...	...	IA:21	...
<i>fusiformis</i> , <i>Agaricus</i>	E:47	...	...	...	...
<i>fusus</i> , <i>Agaricus</i>	C2:13	t.32 f.189	...	IA:22	HE:247
<i>geaster</i> , <i>Lycoperdon</i>	E:151	...	...	SM3:16	...
<i>gemmatum</i> , <i>Lycoperdon</i>	E:147	...	...	SM3:36 , 37	...
<i>giganteum</i>, <i>Lycoperdon</i>	C1:237	t.29 f.165	SMF:140	SM3:29	...
<i>gigas</i>, <i>Phallus</i>	E:131	...	...	SM2:11	...
<i>glandifer</i> , <i>Agaricus</i>	C1:99	t.18 f.86	...	SM1:166	HE:163

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<i>glaucus</i> , <i>Agaricus</i>	C1:169	t.24 f.123	SMF:484	SM1:191	HE:460
<i>glaucus</i> , <i>Mucor</i>	E:157	...	...	...	...
<i>globularis</i> , <i>Sphaeria</i>	C1:271	t.30 f.180	SMF:75	SM2:457	...
<i>glutinosus</i> var. α , <i>Agaricus</i>	C1:61	t.15 f.70	...	...	...
<i>glutinosus</i> var. β , <i>Agaricus</i>	C1:65	t.15 f.71	...	...	...
<i>glutinosus</i> var. γ , <i>Agaricus</i>	C2:43	t.35 f.200	...	SM1:36, IA:22	HE:414
<i>granulosus</i>, <i>Agaricus</i>	E:79 (169)	t.6 f.24	SMF:264	SM1:25	HE:36
<i>grisea</i> , <i>Peziza</i>	E:117 (181)	t.12 f.55	...	SM2:143	...
<i>griseus</i> , <i>Agaricus</i>	C1:87	t.17 f.80	...	SM1:145, EF1:21	HE:146
<i>gyrans</i>, <i>Clavaria</i>	C1:235	t.28 f.164	SMF:606	SM1:494	HE:684
<i>hepatica</i> , <i>Peziza</i>	C1:199	t.26 f.138	...	SM2:71, IA:132	...
<i>hepaticus</i> , <i>Agaricus</i>	E:43 (165)	t.4 f.15	...	SM1:315	...
<i>hepaticus</i> var. α , <i>Agaricus</i>	E:43 (165)	t.4 f.15	...	...	...
<i>hepaticus</i> var. β , <i>Agaricus</i>	E:43	...	...	...	...
<i>hepaticus</i> var. γ , <i>Agaricus</i>	E:43	...	...	...	...
<i>hians</i> , <i>Peziza</i>	E:121	...	...	...	...
<i>hirsuta</i> , <i>Peziza</i>	E:127	...	...	...	...
<i>hirsutus</i> , <i>Boletus</i>	E:99	...	...	IA:59	...
<i>hirta</i> , <i>Clavaria</i>	C1:229	t.28 f.160	...	SM2:327	...
<i>hirtum</i> , <i>Lycoperdon</i>	E:145	...	...	SM3:40	...
<i>hirudo</i> , <i>Peziza</i>	C1:213	t.27 f.149	...	SM2:124	...
<i>hispidus</i> , <i>Agaricus</i>	E:81 (169)	t.6 f.25	...	SM1:201	...
<i>hyacinthus</i> , <i>Agaricus</i>	E:81 (171)	t.7 f.28	SMF:335	SM1:103	HE:419
<i>hypni</i> , <i>Agaricus</i>	C1:117	t.19 f.96	SMF:385	SM1:267	[HE:270, 720]
<i>hypoxylon</i> , <i>Clavaria</i>	E:139	...	...	...	...
<i>hystricinum</i> , <i>Hydnum</i>	E:113	...	...	SM1:410 [517]	HE:618
<i>ichoratus</i> , <i>Agaricus</i>	C1:37	t.13 f.60	SMF:431	SM1:71	HE:436
<i>igniarius</i> , <i>Boletus</i>	E:109	...	...	...	...
<i>igniarius</i> var. α , <i>Boletus</i>	E:109	...	...	...	...
<i>igniarius</i> var. β , <i>Boletus</i>	E:109	...	...	...	...
<i>igniarius</i> var. γ , <i>Boletus</i>	E:109	...	...	...	...
<i>igniarius</i> var. δ , <i>Boletus</i>	E:109	...	...	...	...
<i>imbricatus</i> , <i>Agaricus</i>	C1:149	t.22 f.114	...	SM1:243	HE:220
<i>imperialis</i> , <i>Agaricus</i>	E:59	...	SMF:253	SM1:16	...
<i>imperialis</i> var. α , <i>Agaricus</i>	E:59	...	...	...	...
<i>imperialis</i> var. β , <i>Agaricus</i>	E:59	...	...	...	...
<i>impuer</i> , <i>Agaricus</i>	E:85 (C1:155)	t.23 f.116	...	SM1:42	...
<i>incarnatus</i> , <i>Agaricus</i>	E:51	...	...	SM1:277	HE:182
<i>infundibuliformis</i> , <i>Boletus</i>	E:97	...	...	IA:59	...
<i>infundibuliformis</i> , <i>Peziza</i>	E:121	...	...	IA:133	...
<i>infundibulum</i>, <i>Peziza</i>	C1:211	t.27 f.147	SMF:660	SM2:130	...
<i>involutus</i>, <i>Agaricus</i>	C1:39	t.13 f.61	SMF:448	SM1:271, EF1:10	HE:403
<i>janthinus</i> , <i>Agaricus</i>	E:79 (167)	t.5 f.20	SMF:339	SM1:151	HE:133
<i>janthinus</i> var. α , <i>Agaricus</i>	E:79	...	...	...	...
<i>janthinus</i> var. β , <i>Agaricus</i>	E:79	...	...	...	...
<i>janthinus</i> var. γ , <i>Agaricus</i>	E:79 (167)	t.5 f.20	...	...	...
<i>jenensis</i> , <i>Agaricus</i>	E:83	t.7 f.29	SMF:422	SM1:288	HE:291
<i>jenensis</i> , <i>Peziza</i>	E:123 (C1:219)	t.28 f.153	...	SM2:154	...

Taxon	Page citation	Figure citation	Persoon (1801)	Fries (1821–32)	Fries (1874)
<i>laceratus</i> , Agaricus	E:57	...	...	...	...
<i>lacerum</i> , Lycoperdon	E:145	...	...	SM3:33	...
<i>lacrimalis</i> , Agaricus	E:75 (163)	t.3 f.7–8	...	SM1:266	HE:257, 262
<i>lacteus</i> , Agaricus	E:39	...	...	...	...
<i>lacteus</i> , Boletus	E:103 (177)	t.10 f.42	SMF:517	SM1:348	HE:526
<i>lacteus</i> var. α , Boletus	E:103 (177)	t.10 f.42	...	...	...
<i>lacteus</i> var. β , Boletus	E:103	...	...	...	...
<i>lacteus</i> var. γ , Boletus	E:103	...	...	...	...
<i>lacteus</i> var. δ , Boletus	E:103	...	...	...	...
<i>lanatum</i> , Lycoperdon	E:147	...	...	SM3:40	...
<i>laterinus</i> , Agaricus	C2:29	t.33 f.195	[SMF:326]	[SM1:249] IA:27	...
<i>lateritius</i> , Agaricus	E:41	...	[SMF:326, in error]	[SM1:249, IA:27, in error]	...
leporina , Peziza	E:117	...	SMF:637	SM2:47	...
<i>libertatis</i> , Agaricus	C1:43	t.14 f.62	...	IA:27	HE:300
<i>lilacina</i> , Helvella	C1:187	t.25 f.131	SMF:572	SM1:440	...
<i>lipsiensis</i> , Boletus	C1:183	t.25 f.130	SMF:537	SM1:374, IA:60	HE:558
<i>livescens</i> , Agaricus	C1:53	t.14 f.67	...	SM1:59	...
<i>lividorubescens</i> , Agaricus	C2:51	t.36 f.202	SMF:437	SM1:66	HE:427
<i>lumbricale</i> , Lycoperdon	C1:259	t.30 f.174	SMF:182	SM3:188	...
<i>lumbricalis</i> , Clavaria	E:135	...	...	...	...
<i>luridus</i> , Agaricus	C1:107	t.18 f.90	...	SM1:206	...
<i>luteolus</i> , Agaricus	C1:163	t.23 f.120	...	SM1:318	...
<i>luteum</i> , Lycoperdon	E:155	...	...	SM3:93	...
<i>luteus</i> , Agaricus	E:45	...	...	SM1:41, IA:29	...
<i>luteus</i> , Boletus	E:99	...	...	...	...
<i>luxurians</i> , Agaricus	E:49	...	...	...	...
<i>maculatus</i> , Agaricus	E:41	...	...	...	...
<i>madreporeus</i> , Agaricus	C2:53	t.36,37 f.203	SMF:xxix	SM1:44, IA:29	HE:59
<i>mappa</i> , Agaricus	E:57	...	SMF:251	...	HE:19
<i>margaritiferus</i> , Agaricus	E:57	...	...	SM1:18	...
<i>margaritiferus</i> var. α , Agaricus	E:57	...	...	...	...
<i>margaritiferus</i> var. β , Agaricus	E:57	...	...	...	...
<i>marginatus</i> , Agaricus	C2:65	t.37 f.207	SMF:272	SM1:245	HE:225
<i>membrana</i> , Boletus	E:105	...	...	...	...
<i>membrana</i> var. α , Boletus	E:105	...	...	...	...
<i>membrana</i> var. β , Boletus	E:105	...	...	...	...
<i>mesentericus</i> , Agaricus	E:91	...	...	...	...
<i>mesentericus</i> var. α , Agaricus	E:91	...	...	...	...
<i>mesentericus</i> var. β , Agaricus	E:91	...	...	...	...
<i>mesentericus</i> var. γ , Agaricus	E:91	...	...	...	...
<i>melchii</i> , Clavaria	E:139	...	...	...	...
<i>militaris</i> , Clavaria	E:135	...	...	...	...
<i>miniata</i> , Peziza	C1:207	t.27 f.144	...	...	...
<i>miniatus</i> , Agaricus	E:73	...	...	...	...
minutissima , Peziza	C1:205	t.27 f.143	...	SM2:137, IA:134	...
<i>mitella</i> , Agaricus	E:63	...	...	...	...
<i>mitella</i> var. α , Agaricus	E:63	...	...	...	...
<i>mitella</i> var. β , Agaricus	E:63	...	...	...	...
<i>mitella</i> var. γ , Agaricus	E:63	...	...	...	...
<i>modestus</i> , Agaricus	E:55	...	...	IA:30	...
<i>mollis</i> , Agaricus	E:45 (165)	t.4 f.14	...	SM1:121	HE:113

Taxon	Page citation	Figure citation	Persoon (1801)	Fries (1821–32)	Fries (1874)
<i>mucedo</i> , <i>Mucor</i>	E:157	...	...	...	...
<i>mucor</i>, <i>Agaricus</i>	C1:91	t.17 f.82	SMF:469	SM1:155	HE:152
<i>multifidum</i> , <i>Lycoperdon</i>	E:151	...	...	IA:112	...
<i>multifidus</i> , <i>Agaricus</i>	C1:173	t.24 f.126	SMF:485	SM1:330	HE:492
<i>muricatum</i> , <i>Lycoperdon</i>	E:145	...	...	...	...
<i>murinus</i>, <i>Agaricus</i>	E:79 (167)	t.5 f.19	...	SM1:115	HE:128
<i>mutabilis</i> , <i>Agaricus</i>	C2:69	t.38 f.208	SMF:271	SM1:245	...
<i>mutabilis</i> , <i>Boletus</i>	E:99	...	...	...	...
<i>mutabilis</i> var. α , <i>Boletus</i>	E:99	...	...	...	...
<i>mutabilis</i> var. β , <i>Boletus</i>	E:99	...	...	...	...
<i>mutabilis</i> var. γ , <i>Boletus</i>	E:99	...	...	...	...
<i>mutabilis</i> var. δ , <i>Boletus</i>	E:101	...	...	...	...
<i>mutabilis</i> var. ϵ , <i>Boletus</i>	E:101	...	...	...	...
<i>mutabilis</i> var. ζ , <i>Boletus</i>	E:101	...	...	...	...
<i>narcoticus</i>, <i>Agaricus</i>	C1:79	t.16 f.77	SMF:405	SM1:311	HE:329
<i>nebularis</i>, <i>Agaricus</i>	C2:25	t.33 f.193	SMF:349	SM1:86	HE:79
<i>neptuneus</i> , <i>Agaricus</i>	C1:161	t.23 f.118	...	SM1:98, IA:31	HE:86
<i>nimbatus</i> , <i>Agaricus</i>	C1:49	t.14 f.65	...	SM1:87	HE:81
<i>nitens</i>, <i>Agaricus</i>	C2:21	t.33 f.192	SMF:359	SM1:116 , 511, IA:32	HE:421
<i>nitens</i> , <i>Boletus</i>	E:109	...	SMF:522	...	...
<i>nitens</i> var. α , <i>Boletus</i>	E:109	...	...	IA:60	...
<i>nitens</i> var. β , <i>Boletus</i>	E:109	...	...	IA:60	...
<i>nitens</i> var. γ , <i>Boletus</i>	E:109	...	...	IA:60	...
<i>nitens</i> var. δ , <i>Boletus</i>	E:109	...	...	...	...
<i>nitens</i> var. ϵ , <i>Boletus</i>	E:109	...	...	...	...
<i>nitens</i> var. ζ <i>crocatus</i> , <i>Boletus</i>	C2:113	t.41 f.225	...	SM1:353	HE:537
<i>nivea</i> , <i>Peziza</i>	E:117 (181)	t.12 f.56	...	SM2:136, 143	...
<i>niveobrunneus</i> , <i>Agaricus</i>	E:77	...	...	...	...
<i>niveoflavens</i> , <i>Agaricus</i>	E:75	...	...	...	...
<i>nivosus</i> , <i>Agaricus</i>	C1:49	t.14 f.64	...	IA:32	HE:81
<i>nutans</i> , <i>Peziza</i>	E:121	...	...	SM2:125, SM3:151	...
<i>nutans</i> var. α , <i>Peziza</i>	E:121	...	...	...	...
<i>nutans</i> var. β , <i>Peziza</i>	E:121	...	...	[SM3:150, IA:128]	...
<i>obesus</i> , <i>Agaricus</i>	C2:89	t.39 f.216	SMF:330	SM1:257, IA:32	HE:198
<i>obsolescens</i> , <i>Agaricus</i>	C1:127	t.20 f.102	...	SM1:172	...
<i>obsoletus</i> , <i>Agaricus</i>	C1:129	t.20 f.103	...	SM1:172	HE:105
<i>occarium</i>, <i>Hydnum</i>	E:113	...	...	SM1:412	...
<i>occultans</i> , <i>Agaricus</i>	E:55	...	...	SM1:30	...
<i>ochraceus</i> , <i>Agaricus</i>	E:51 (167)	t.4 f.17	...	IA:33	[HE:392, 721]
<i>officinalis</i>, <i>Boletus</i>	E:111	...	...	SM1:365, IA:61	...
<i>olivacea</i>, <i>Peziza</i>	E:127 (181)	t.12 f.51	SMF:666	SM2:142	...
<i>olivaceus</i> , <i>Agaricus</i>	E:45	...	...	IA:33	...
<i>olivascens</i> , <i>Agaricus</i>	C2:3	t.31 f.185	...	SM1:39, IA:33	HE:354
<i>olla</i>, <i>Peziza</i>	E:127	...	[SMF:237]	IA:135	...
<i>olla</i> var. α , <i>Peziza</i>	E:127	...	...	...	...
<i>olla</i> var. β , <i>Peziza</i>	E:127	...	...	...	...
<i>ophioglossoides</i> , <i>Clavaria</i>	E:135	...	...	...	...
<i>ophioglossoides</i> var. α , <i>Clavaria</i>	E:135	...	...	...	...
<i>ophioglossoides</i> var. β , <i>Clavaria</i>	E:135	...	...	...	...
<i>ophioglossoides</i> var. γ , <i>Clavaria</i>	E:135	...	...	...	...

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<i>ophioglossoides</i> var. δ , <i>Clavaria</i>	E:135	...	...	...	...
<i>ophioglossoides</i> var. ϵ , <i>Clavaria</i>	E:135	...	...	...	...
<i>orichalceus</i> , <i>Agaricus</i>	C2:1	t.31 f.184	...	SM1:223	HE:348
<i>ovum</i> , <i>Agaricus</i>	E:55	...	...	...	...
<i>pallescens</i> , <i>Agaricus</i>	E:61	...	...	...	...
<i>pallor</i> , <i>Agaricus</i>	C1:115	t.18 f.95	...	SM1:134	...
<i>palmiforme</i> , <i>Lycoperdon</i>	E:149	...	...	[SM3:42, IA:112]	...
<i>papillatus</i> , <i>Agaricus</i>	C1:81	t.17 f.78	SMF:406	SM1:312	HE:326
<i>patella</i> , <i>Agaricus</i>	E:85	...	...	...	...
<i>pauperatus</i> , <i>Agaricus</i>	E:53	...	...	...	...
<i>pectiniforme</i> , <i>Hydnum</i>	E:113	...	...	SM1:412 [IA:100]	...
<i>pedicellatum</i> , <i>Lycoperdon</i>	E:151	...	...	SM3:13	...
<i>pedunculata</i> , <i>Clavaria</i>	E:135	...	...	...	...
<i>pedunculatum</i> , <i>Lycoperdon</i>	E:149 (C1:241)	t.29 f.167	SMF:139	SM3:43	...
<i>pedunculatus</i> , <i>Clathrus</i>	E:141	...	...	IA:71	...
<i>pellitus</i> , <i>Agaricus</i>	E:55	...	...	...	...
<i>peltigerus</i> , <i>Agaricus</i>	C2:17	t.32 f.190	...	...	HE:359
<i>perennis</i> , <i>Boletus</i>	E:103 (C1:181)	t.25 f.129	SMF:523	SM1:352	...
<i>pertusus</i> , <i>Clathrus</i>	E:143	...	...	...	...
[= <i>Embolus pertusus</i>]	E:143	...	...	...	...
<i>pertusus</i> , <i>Embolus</i>	E:143	...	...	...	...
[= <i>Clathrus pertusus</i>]	C1:263	t.30 f.176	SMF:187	SM3:158	...
<i>pileatus</i> , <i>Agaricus</i>	C1:47	t.14 f.63	...	IA:35	...
<i>pilosus</i> , <i>Agaricus</i>	E:67 (159)	t.1 f.2	SMF:381	SM1:142	HE:144
<i>pineti</i> , <i>Agaricus</i>	E:73 (163)	t.3 f.9	...	IA:35	HE:470
<i>pineti</i> var. α , <i>Agaricus</i>	E:73	...	...	...	...
<i>pineti</i> var. β , <i>Agaricus</i>	E:73 (163)	t.3 f.9	...	...	...
<i>pineti</i>, <i>Peziza</i>	C1:201	t.26 f.140	SMF:666	SM2:101	...
<i>pineum</i> , <i>Lycoperdon</i>	E:155	...	...	SM3:192	...
<i>piperatus</i> , <i>Agaricus</i>	C1:33	t.13 f.59	SMF:429	SM1:76	HE:430
<i>pistillaris</i> , <i>Agaricus</i>	E:55	...	...	SM1:30	...
<i>pistillaris</i> , <i>Clavaria</i>	E:133 (179)	t.11 f.46	SMF:597	SM1:477	...
<i>pistillaris</i> var. α , <i>Clavaria</i>	E:133 (179)	t.11 f.46	...	...	...
<i>pistillaris</i> var. β , <i>Clavaria</i>	E:133	...	...	...	...
<i>pistillaris</i> var. γ , <i>Clavaria</i>	E:133	...	...	...	...
<i>placenta</i> , <i>Agaricus</i>	E:79 (167)	t.5 f.18	SMF:351	SM1:195	HE:190
<i>plicatus</i> , <i>Agaricus</i>	E:63	...	...	...	...
<i>pluteus</i>, <i>Agaricus</i>	E:79	...	SMF:357	SM1:199	...
<i>polyrhizon</i> , <i>Lycoperdon</i>	E:147	...	...	SM3:46, 48	...
<i>porphyrea</i> , <i>Peziza</i>	E:127 (181)	t.12 f.53	SMF:633	SM2:168	...
<i>pratensis</i> , <i>Agaricus</i>	E:77 (161)	t.2 f.5	...	SM1:124	...
<i>pruinatus</i> , <i>Agaricus</i>	E:93 (175)	t.9 f.35	SMF:490	SM1:320	...
<i>pseudodeliciosus</i> , <i>Agaricus</i>	E:91	...	...	...	...
<i>pseudounctuosus</i> , <i>Agaricus</i>	E:93 (175)	t.9 f.37	...	SM1:318	HE:456
<i>puccinia</i> , <i>Clavaria</i>	E:139 (179)	t.11 f.49	SMF:688	SM3:294	...
<i>puella</i> , <i>Agaricus</i>	E:59	...	SMF:253	IA:37	...
<i>pullus</i> , <i>Agaricus</i>	E:47	...	...	...	...
<i>pullus</i> var. α , <i>Agaricus</i>	E:47	...	...	SM1:44	...
<i>pullus</i> var. β , <i>Agaricus</i>	E:47	...	...	...	...
<i>pullus</i> var. γ , <i>Agaricus</i>	E:47	...	...	SM1:44	...
<i>punicea</i> , <i>Peziza</i>	C2:97	t.39 f.220	...	SM2:71	...

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<i>purpurascens</i> , <i>Agaricus</i>	E:93	...	...	IA:37	...
<i>pusillum</i>, <i>Lycoperdon</i>	C2:123	t.41 f.228	SMF:138	SM3:33	...
<i>pusillus</i> , <i>Agaricus</i>	C1:51	t.14 f.66	...	SM1:141	...
<i>pyriforme</i> , <i>Lycoperdon</i>	E:147	...	...	...	...
<i>pyxis</i> , <i>Peziza</i>	E:129	...	...	...	...
<i>quercinus</i> , <i>Agaricus</i>	E:95	...	...	...	...
<i>radians</i> , <i>Agaricus</i>	E:61	...	...	...	...
<i>radiatum</i> , <i>Lycoperdon</i>	E:151	...	...	...	...
<i>resinosorum</i> , <i>Clavaria</i>	E:139	...	...	...	...
<i>rete</i> , <i>Phallus</i>	E:131	...	...	SM2:11	...
<i>risigallinus</i> , <i>Agaricus</i>	C1:67	t.15 f.72	SMF:442	SM1:56	HE:454
<i>rosellus</i> , <i>Agaricus</i>	C1:121	t.19 f.99	SMF:453	SM1:107	HE:108
[<i>roseus</i> , <i>Aspergillus</i>]	(E:183)	t.12 f.58	SMF:691	SM3:386	...
<i>rostratus</i> , <i>Agaricus</i>	E:65	...	...	IA:39	...
<i>rubellus</i> , <i>Agaricus</i>	E:39	...	...	...	...
<i>runderatus</i> , <i>Agaricus</i>	E:59	...	...	SM1:17	...
<i>rudolphii</i> , <i>Agaricus</i>	E:45 (169)	t.6 f.23	...	SM1:121, IA:40	HE:392
<i>rufolivescens</i> , <i>Agaricus</i>	E:85	...	...	...	...
<i>rufolivescens</i> var. <i>α</i> , <i>Agaricus</i>	E:85	...	...	...	...
<i>rufolivescens</i> var. <i>β</i> , <i>Agaricus</i>	E:85	...	...	...	...
<i>saccharinus</i>, <i>Agaricus</i>	C1:93	t.17 f.83	SMF:469	SM1:160	HE:479
<i>sanguinalis</i> , <i>Agaricus</i>	C2:47	t.36 f.201	SMF:430	SM1:62	HE:424
<i>sanguineus</i> , <i>Agaricus</i>	E:39 (165)	t.3 f.13	...	SM1:57	HE:444
<i>sanguineus</i> var. <i>α</i> , <i>Agaricus</i>	E:39	...	...	...	...
<i>sanguineus</i> var. <i>β</i> , <i>Agaricus</i>	E:39 (165)	t.3 f.13	...	...	...
<i>sanguineus</i> var. <i>γ</i> , <i>Agaricus</i>	E:39	...	...	...	...
<i>sceptrum</i>, <i>Peziza</i>	E:123	...	SMF:644	SM2:56	...
<i>schenkii</i>, <i>Peziza</i>	E:125 (181)	t.12 f.52	...	SM2:71	...
<i>scutellata</i> , <i>Peziza</i>	E:123 (181)	t.12 f.54	...	SM2:86	...
<i>scutellata</i> var. <i>α</i> , <i>Peziza</i>	E:123 (181)	t.12 f.54	...	...	...
<i>scutellata</i> var. <i>β</i> , <i>Peziza</i>	E:123	...	...	...	...
<i>scutellata</i> var. <i>γ</i> , <i>Peziza</i>	E:125	...	...	...	...
<i>scutellata</i> var. <i>δ</i> , <i>Peziza</i>	C1:221	t.28 f.154	SMF:648	...	...
<i>semiglobatus</i>, <i>Agaricus</i>	C1:141	t.21 f.110	SMF:408	SM1:284	HE:287
<i>seminulum</i> , <i>Peziza</i>	E:117	...	...	...	...
<i>senescens</i> , <i>Agaricus</i>	C2:35	t.34 f.197	...	IA:41	HE:355
<i>sepulcralis</i> , <i>Helvella</i>	C1:191	t.26 f.133	...	[SM3:189] IA:97	...
<i>sepulcralis</i> , <i>Peziza</i>	E:119	...	...	IA:137	...
<i>sericeus</i> , <i>Agaricus</i>	E:45	...	...	...	...
<i>serpentiformis</i> , <i>Agaricus</i>	E:89	...	...	[SM1:176] IA:41	...
<i>sigillatoria</i>, <i>Peziza</i>	C1:205	t.27 f.142	...	SM2:137, IA:137	...
<i>simulans</i> , <i>Agaricus</i>	E:85	...	...	IA:41	...
<i>spadicea</i> , <i>Peziza</i>	C2:93	t.39 f.217	...	SM2:154	...
<i>spadiceus</i> , <i>Agaricus</i>	E:49 (165)	t.4 f.16	...	SM1:223	HE:339
<i>sphaerocephalus</i> , <i>Mucor</i>	E:157	...	...	...	...
<i>sphinx</i>, <i>Agaricus</i>	C1:145	t.22 f.112	SMF:315	SM1:119	HE:115
<i>spiculosa</i> , <i>Sphaeria</i>	C1:273	t.30 f.182	SMF:36	SM2:436	...
<i>spongiosum</i> , <i>Hydnum</i>					
<i>suberosum</i> var. <i>α</i>	C2:99	t.40 f.221	SMF:xxix, 556	SM1:404	...

Taxon	Page citation	Figure citation	Persoon (1801)	Fries (1821-32)	Fries (1874)
<i>squamula</i> , <i>Agaricus</i>	C1:95	t.17 f.84	SMF:468	SM1:139	HE:479
<i>squamulosus</i> , <i>Agaricus</i>	C1:157	t.23 f.117	SMF:297	SM1:229	HE:371
<i>squarrosus</i> , <i>Agaricus</i>	E:85 (173)	t.8 f. 31	...	SM1:243	HE:222
<i>stellatum</i> , <i>Lycoperdon</i>	E:145	...	...	SM3:33	...
<i>stellatum</i> var. α , <i>Lycoperdon</i>	E:145	...	...	...	...
<i>stellatum</i> var. β , <i>Lycoperdon</i>	E:145	...	...	...	...
<i>stellatus</i> , <i>Agaricus</i>	E:63	...	...	...	...
<i>striatellus</i> , <i>Agaricus</i>	E:69	...	...	...	...
<i>suaveolens</i> , <i>Boletus</i>	E:97	...	...	...	...
<i>subalutaceus</i>, <i>Agaricus</i>	C2:27	t.33 f.194	...	SM1:90, EF1:15	HE:84
<i>subannulatus</i> , <i>Agaricus</i>	C1:75	t.16 f.75	...	SM1:31, IA:43	HE:41
<i>subantiquatus</i> , <i>Agaricus</i>	C2:59	t.37 f.205	SMF:260	SM1:22 [508]	HE:33
<i>subatratus</i> , <i>Agaricus</i>	C1:103	t.18 f.89	...	IA:43	HE:313
<i>subcarneus</i> , <i>Agaricus</i>	C1:123	t.19 f.100	SMF:453	SM1:107	HE:108
<i>subcoriaceus</i> , <i>Agaricus</i>	E:71	...	...	...	...
<i>subcorneus</i> , <i>Agaricus</i>	E:83	...	...	...	...
<i>subcyaneus</i> , <i>Agaricus</i>	E:47	...	...	...	...
<i>suberosum</i> , <i>Hydnum</i>	E:113 (179)	t.10 f.45	...	...	...
<i>suberosum</i> var. α					
<i>spongiosum</i> , <i>Hydnum</i>	C2:99	t.40 f.221	SMF:xxix, 556	SM1:404	...
<i>suberosum</i> var. β					
<i>aurantiacum</i>, <i>Hydnum</i>	C2:103	t.40 f.222	SMF:xxx	SM1:403, 516	...
<i>suberosum</i> var. γ					
<i>cinereum</i> , <i>Hydnum</i>	C2:107	t.40 f.223	SMF:xxx	SM1:404	HE:605
<i>suberosus</i> , <i>Boletus</i>	E:107	...	...	SM1:363	...
<i>suberosus</i> var. α					
<i>flabelliformis</i> , <i>Boletus</i>	C2:117	t.41 f.226	...	SM1:363	HE:549
<i>suberosus</i> var. β					
<i>conchiformis</i> , <i>Boletus</i>	C2:121	t.41 f.227	SMF:529	SM1:363	...
<i>subferrugineus</i>, <i>Agaricus</i>	C2:7	t.31 f.186	...	SM1:234	HE:387
<i>subgracilis</i> , <i>Agaricus</i>	E:59	...	...	...	...
<i>subgranulatus</i> , <i>Agaricus</i>	E:45 (169)	t.5 f.22	...	SM1:225	...
<i>subhepaticus</i> , <i>Agaricus</i>	C2:77	t.38 f.211	SMF:428	SM1:164	[HE:160, 719]
<i>subinvolutus</i> , <i>Agaricus</i>	C2:57	t.37 f.204	SMF:431	SM1:80	...
<i>submaculatus</i> , <i>Agaricus</i>	E:87	...	...	...	...
<i>submaculatus</i> var. α , <i>Agaricus</i>	E:87	...	...	...	...
<i>submaculatus</i> var. β , <i>Agaricus</i>	E:89	...	...	...	...
<i>subpurpurascens</i> , <i>Agaricus</i>	C1:71	t.16 f.74	SMF:280	SM1:224	HE:346
<i>subsquamosum</i>, <i>Hydnum</i>	E:111 (177)	t.10 f.43	...	SM1:399	HE:598
<i>subsquamosum</i> var. α , <i>Hydnum</i>	E:111	...	...	...	...
<i>subsquamosum</i> var. β , <i>Hydnum</i>	E:111 (177)	t.10 f.43	...	...	...
<i>subsquamosus</i> , <i>Boletus</i>	E:97 (177)	t.10 f.41	...	...	...
<i>subsquamulosus</i> , <i>Agaricus</i>	C2:19	t.33 f.191	...	SM1:230	HE:374
<i>subtestaceus</i> , <i>Agaricus</i>	C2:39	t.35 f.198	...	SM1:249	[HE:238, 735]
<i>subulatus</i> , <i>Agaricus</i>	E:65	...	...	IA:44	...
<i>subviolascens</i> , <i>Agaricus</i>	E:47	...	...	...	...
<i>succineus</i> , <i>Agaricus</i>	E:61	...	...	...	...
<i>sulphuratus</i> , <i>Agaricus</i>	E:67	...	...	...	...
<i>sulphurea</i> , <i>Peziza</i>	E:121 (C1:209)	t.27 f.146	...	SM2:123	HE:665

Taxon	Page citation	Figure citation	Persoon (1801)	Fries (1821–32)	Fries (1874)
<i>tenella</i> , <i>Peziza</i>	C1:215	t.27 f.151	SMF:662	SM2:124	...
<i>tenellus</i> , <i>Agaricus</i>	C1:103	t.18 f.88	SMF:384	SM1:155	HE:150
<i>tentaculata</i> , <i>Sphaeria</i>	C1:277	t.30 f.183	SMF:39	SM2:365, IA:175	...
<i>tintinnabulum</i> , <i>Agaricus</i>	E:67 (161)	t.1 f.3	...	SM1:305	HE:316
<i>tortus</i> , <i>Agaricus</i>	E:61	...	...	...	...
<i>tremulans</i> , <i>Agaricus</i>	C2:73	t.38 f.209	...	SM1:124	HE:120
<i>tremulus</i> , <i>Agaricus</i>	C1:129	t.20 f.104	SMF:368	SM1:123, IA:45	HE:117
<i>tristis</i> , <i>Agaricus</i>	C1:165	t.24 f.121	...	SM1:431	HE:635
<i>truncatum</i> , <i>Lycoperdon</i>	C2:129	t.42 f.230	...	...	...
<i>tuba</i>, <i>Peziza</i>	E:121	...	SMF:644	SM2:58 [612]	...
<i>tuber</i> , <i>Lycoperdon</i>	E:143	...	...	...	...
<i>tubiformis</i> , <i>Agaricus</i>	E:77	...	...	...	...
 <i>umbraculum</i> , <i>Agaricus</i>	E:77 (161)	t.2 f.4	...	SM1:118	...
<i>unctuosa</i>, <i>Helvella</i>	C1:193	t.26 f.134	...	SM2:31, IA:97	...
<i>unctus</i> , <i>Agaricus</i>	E:83	...	...	IA:46	...
<i>undosus</i>, <i>Phallus</i>	E:131	...	...	SM2:11	...
 <i>variabilis</i> , <i>Agaricus</i>	E:67	...	...	...	...
<i>vellus</i> , <i>Agaricus</i>	E:49	...	...	...	...
<i>ventricosus</i> , <i>Agaricus</i>	E:89	...	...	...	...
<i>vermicularis</i> , <i>Clavaria</i>	E:135	...	...	...	...
<i>verrucosum</i> , <i>Lycoperdon</i>	E:155	...	...	SM3:82, IA:114	...
<i>versicolor</i> , <i>Boletus</i>	E:107	...	...	...	...
<i>versicolor</i> var. α , <i>Boletus</i>	E:107	...	...	...	...
<i>versicolor</i> var. β , <i>Boletus</i>	E:107	...	...	...	...
<i>versicolor</i> var. γ , <i>Boletus</i>	E:107	...	...	...	...
<i>versicolor</i> var. δ , <i>Boletus</i>	E:107	...	...	...	...
<i>vesiculosum</i> , <i>Lycoperdon</i>	C1:253	t.29 f.171	...	SM3:188	...
<i>vesparium</i> , <i>Lycoperdon</i>	C1:253	t.30 f.172	SMF:177	SM3:183	...
<i>violaceofulvens</i>, <i>Agaricus</i>	E:95 (177)	t.9 f.39	SMF:483	SM1:276	HE:490
<i>violaceus</i> , <i>Agaricus</i>	E:47	...	...	...	...
<i>virens</i> , <i>Mucor</i>	E:157	...	...	...	...
<i>virginea</i>, <i>Peziza</i>	E:125	...	SMF:653	SM2:90	...
<i>virgineus</i> , <i>Agaricus</i>	E:39 (165)	t.3 f.12	SMF:364	SM1:33	...
<i>vitellinus</i> , <i>Agaricus</i>	E:83	...	...	...	...
<i>volvatus</i> , <i>Boletus</i>	E:99	...	...	IA:64	...
<i>volvatus</i> , <i>Phallus</i>	E:133	...	...	IA:141	...
<i>vulneratus</i> , <i>Agaricus</i>	E:53	...	...	SM1:21	...
 <i>zonatum</i> , <i>Hydnum</i>	E:111 (C2:109)	t.40 f.224	SMF:xxx	SM1:405	HE:605
<i>zonatus</i> , <i>Boletus</i>	E:105	...	...	IA:64	...
<i>zonatus</i> var. α , <i>Boletus</i>	E:105	...	...	...	...
<i>zonatus</i> var. β , <i>Boletus</i>	E:105	...	...	...	...

ADDITIONS TO THE KNOWLEDGE OF THE GENUS *CLADONIA* (CLADONIACEAE, LICHENIZED ASCOMYCOTINA) IN THE ALPINE BELT OF THE PYRENEES IN ANDORRA

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Abstract

Field and laboratory studies of the lichen genus *Cladonia* in the alpine meadows of Andorra (NE of Spain, Iberian Peninsula), yielded 24 taxa: 19 species, 3 subspecies and 2 unidentified taxa. *Cladonia galindezii*, earlier believed to be endemic to the Antarctic, is reported for the first time from the Northern Hemisphere. *C. asahinae*, *C. macroceras*, and chemotypes IV of *C. subcariosa* and II of *C. pyxidata* are new reports for Europe. The lichen substances, reported for each taxon, and the altitudinal distribution are discussed.

Key words: Chemotaxonomy, ecology, altitudinal distribution, Iberian Peninsula.

Introduction

As part of a survey of the lichen flora of Andorra (Azuaga *et al.*, in preparation), the genus *Cladonia* was studied in the alpine meadow belt. The secondary chemistry and the altitudinal distribution were evaluated for each taxon. Andorra is a little country located in the Pyrenees adjacent to Spain. Its meadow belt, above the tree line, extending from 2100 m to the highest summit (2942 m), has an area of ca. 173 km².

Materials and Methods

We have standardised the collection method for the alpine belt from 15 mountains (Fig. 1). At every ca. 100 m of altitude we have established one station that was exhaustively explored. A total of 83 stations were studied, and 750 samples of the genus *Cladonia* were collected in the years 1995–1999. The taxa were identified by their morphological and chemical characters. The chemical composition was screened for 450 specimens, by thin-layer chromatography (TLC), following Elix & Ernst-Russell (1993). The taxa were listed alphabetically, following the nomenclature of Eriksson (1999) and Ahti (2000).

The specimens were deposited in the personal herbarium of the first author (Herb. Azu).

Additional specimen investigated: *Cladonia galindezii* Øvstedal: Antarctica, West Graham Land, Galindez Island, 1935, n° 1108 (BM-holotype).

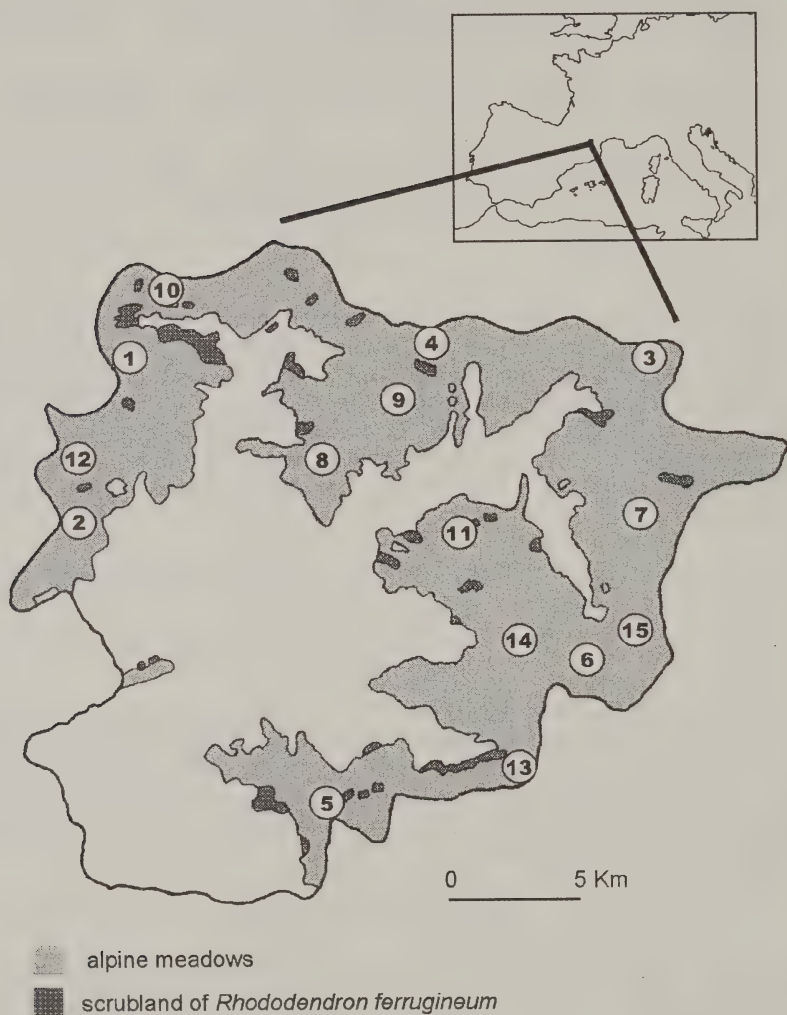


Fig. 1. Location of the 15 study mountains of Andorra.

Mountains

1. Pic Cataperdis, 2500-2805 m, UTM: 31TCH 71. Siliceous substratum (laminated schists).
2. Pic Negre, 2160-2569 m, UTM: 31TCH 71. Calcareous substratum.
3. Coll de Juclar, 2440 m, UTM: 31TCH 91. Siliceous substratum (gneiss).
4. Pic de la Serrera, 2340-2914 m, UTM: 31TCH 81. Siliceous substratum (micaceous schists).
5. Torre dels Soldats, 2380-2760 m, UTM: 31TCH 80. Siliceous substratum (black argillaceous schists and laminated schists).
6. Pic de Montmalús, 2400-2781 m, UTM: 31TCH 90. Siliceous substratum (granodiorite).
7. Pic del Maià, 2614 m, UTM: 31TCH 91. Siliceous substratum (laminated schists).
8. Pic de Casamanya, 2100-2740 m, UTM: 31TCH 81. Calcareous substratum.
9. Pic de l'Estanyó, 2400-2914 m, UTM: 31TCH 81. Siliceous substratum (laminated schists).
10. Pic de Tristaina, 2490-2878 m, UTM: 31TCH 72. Siliceous substratum (micaceous schists).
11. Pic d'Encampadana, 2420-2491 m, UTM: 31TCH 81. Calcareous substratum.
12. Pic de la Coma Pedrosa, 2300-2942 m, UTM: 31TCH 71. Siliceous substratum (black argillaceous schists and laminated schists).
13. Pic de la Portelleta, 2320-2910 m, UTM: 31TCH 80. Siliceous substratum (granodiorite).
14. Pic dels Pessons, 2300-2889 m, UTM: 31TCH 90. Siliceous substratum (granodiorite).
15. Pic de la Menera, 2700-2774 m, UTM: 31TCH 90. Siliceous substratum (granodiorite).

List of taxa

Cladonia arbuscula (Wallr.) Flot. ssp. ***arbuscula*** (= *Cladina arbuscula* (Wallr.) Hale & W.L. Culb. ssp. *squarrosa* (Wallr.) Burgaz)

Acidophilous, from 2500 to 2650 m.

Specimens examined: **6**: Coma Estremera, 2500 m, *Azu.* 657, 666. **13**: Portella de Setut, 2650 m, *Azu.* 1704.

Cladonia asahinae J.W. Thomson

Chemotype I (Brodo & Ahti, 1996). Acidophilous, 2600 m.

Specimens examined: **10**: Costa Rodona, 2600 m, *Azu.* 1386.

Cladonia borealis S. Stenroos

Acidophilous and neutrophilous, from 2420 to 2914 m.

Specimens examined: **3**: Coll de Juclar, 2440 m, *Azu.* 304, 308. **5**: Torre dels Soldats 2760 m, *Azu.* 526. **6**: Coma Estremera 2500 m, *Azu.* 675. **7**: summit of Pic del Maià, 2614 m, *Azu.* 684, 722. **9**: summit of Pic de l'Estanyó,

2914 m, *Azu.* 860; below the summit of Pic de l'Estanyó, 2900 m, *Azu.* 1103; Serra del Roc del Rellotge, 2800 m, *Azu.* 909; 2750 m, *Azu.* 1127 d; 2700 m, *Azu.* 959; 2510 m, *Azu.* 1014, 1017, 1189, 1199, 2070. **10:** summit of Pic de Tristaina, 2878 m, *Azu.* 1302, 1303, 1346; below the summit of Pic de Tristaina, 2800 m, *Azu.* 1232; Collet de les Planes, 2700 m, *Azu.* 1268. **11:** Collet del Cap dels Clots, 2420 m, *Azu.* 1444. **12:** Terregalls de l'Alt, 2700 m, *Azu.* 1506. **13:** summit of Pic de la Portelleta and Tossa Plana de Llès, 2910 m, *Azu.* 1545, 1612; Port de Setut, 2700 m, *Azu.* 1627, 1649, 1689, 1702; Portella de Setut, 2650 m, *Azu.* 1717; 2490 m, *Azu.* 1759. **15:** summit of Pic de la Menara 2774 m, *Azu.* 2003, 2011, 2037.

***Cladonia cariosa* (Ach.) Spreng.**

Acidophilous, from 2400 to 2780 m.

Specimens examined: **1:** Serra del Cap de la Coma, 2780 m, *Azu.* 61. **10:** Costa Rodona, 2560 m, *Azu.* 1277; Estany de Més Amunt, 2490 m, *Azu.* 1396. **13:** Basses de Setut, 2400 m, *Azu.* 1773. **14:** Estany de les Fonts, 2500 m, *Azu.* 1953.

***Cladonia chlorophaea* (Flörke ex Sommerf.) Spreng.**

Acidophilous, from 2340 to 2914 m.

Specimens examined: **1:** summit of Pic de Cataperdis, 2805 m, *Azu.* 60. **4:** Font dels Clots de la Llosa, 2340 m, *Azu.* 421. **6:** summit of Pic de Montmalús, 2781 m, *Azu.* 625. **9:** summit of Pic de l'Estanyó, 2914 m, *Azu.* 1084; Serra del Roc del Rellotge, 2800 m, *Azu.* 893; 2600 m, *Azu.* 981; 2510 m, *Azu.* 2082; Clots de l'Estanyó 2400 m, *Azu.* 1040, 1046, 2093, 2101, 2105. **13:** Port de Setut, 2700 m, *Azu.* 1682, 1684; Portella de Setut, 2650 m, *Azu.* 1730; 2490 m, *Azu.* 1770; Pla d'Inglà, 2350 m, *Azu.* 1782.

***Cladonia diversa* Asperges**

Acidophilous, from 2440 to 2700 m.

Specimens examined: **3:** Coll de Juclar, 2440 m, *Azu.* 294. **9:** Serra del Roc del Rellotge, 2510 m, *Azu.* 2072. **10:** Costa Rodona, 2600 m, *Azu.* 1393. **12:** Terregalls de l'Alt, 2700 m, *Azu.* 1503, 1513.

Cladonia ecmocyna* Leight. ssp. *ecmocyna

Acidophilous, from 2300 to 2600 m.

Specimens examined: **9:** Serra del Roc del Rellotge, 2600 m, *Azu.* 979; Clots de l'Estanyó, 2400 m, *Azu.* 1037, 1038. **13:** Pla d'Inglà, 2350 m, *Azu.* 1785. **14:** Estany Rodó, 2400 m, *Azu.* 1983, 1989; Estany Forcat, 2300 m, *Azu.* 1995, 1997.

***Cladonia fimbriata* (L.) Fr.**

Acidophilous, from 2400 to 2942 m.

Specimens examined: **9:** Clots de l'Estanyó, 2400 m, *Azu.* 2103. **12:** summit of Pic de Coma Pedrosa, 2942 m, *Azu.* 1456, 1471. **14:** below the Collada dels Pessons, 2650 m, *Azu.* 1862.

***Cladonia furcata* (Huds.) Schrad.**

Acidophilous, from 2500 to 2650 m.

Specimens examined: **6**: Coma Estremera, 2500 m, *Azu.* 656. **13**: Portella de Setut, 2650 m, *Azu.* 1718.

***Cladonia galindezii* Øvstedal**

Acidophilous, from 2400 to 2910 m.

Specimens examined: **1**: Serra del Cap de la Coma, 2780 m, *Azu.* 110; 2700 m, *Azu.* 52. **5**: La Serra Airosa, 2700 m, *Azu.* 481, 485. **9**: Clots de l'Estanyó, 2400 m, *Azu.* 1048. **10**: Costa Rodona, 2560 m, *Azu.* 1276. **13**: summit of Pic de la Portelleta and Tossa Plana de Llès, 2910 m, *Azu.* 1552; ridge of Pic de Setut, 2900 m, *Azu.* 1613.

***Cladonia homosekikaica* Nuno**

Acidophilous, from 2380 to 2510 m.

Specimens examined: **1**: south of Tarteres del Cap de la Coma, 2500 m, *Azu.* 66. **5**: Coll de Finestres, 2380 m, *Azu.* 589. **9**: Serra del Roc del Rellotge, 2510 m, *Azu.* 2068; Clots de l'Estanyó, 2400 m, *Azu.* 2100.

***Cladonia macroceras* (Delise) Hav.**

Chemotype I (Fumarprotocetraric acid as major substance and protocetraric, confumarprotocetraric and convirensic acids as minor substances).

Acidophilous, from 2320 to 2914 m.

Chemotype II (Atranorin and fumarprotocetraric acid as major substances and protocetraric and confumarprotocetraric acids as minor substances).

Acidophilous, from 2490 to 2600 m.

Specimens examined: **Chemotype I**: **1**: Tarteres del Cap de la Coma, 2690 m, *Azu.* 67; 2620 m, *Azu.* 55. **3**: Coll de Juclar, 2440 m, *Azu.* 312. **4**: summit of Pic de la Serrera, 2914 m, *Azu.* 330; Llac Petit dels Meners de la Coma, 2490 m, *Azu.* 393, 403, 409. **5**: La Serra Airosa, 2700 m, *Azu.* 466, 507. **6**: Coma Estremera, 2500 m, *Azu.* 665, 669, 680. **7**: summit of Pic del Maià, 2614 m, *Azu.* 728. **9**: summit of Pic de l'Estanyó, 2914 m, *Azu.* 875; 2900 m, *Azu.* 1118; Serra del Roc del Rellotge, 2800 m, *Azu.* 925, 928; 2750 m, *Azu.* 1129; 2700 m, *Azu.* 955; 2600 m, *Azu.* 980, 986, 990, 1150; 2510 m, *Azu.* 1010, 1011, 2073; 2400 m, *Azu.* 1042. **10**: summit of Pic de Tristaina, 2878 m, *Azu.* 1318, 1339; Collet de les Planes, 2700 m, *Azu.* 1248, 1257, 1350, 1375; over the Estany de Més Amunt, 2540 m, *Azu.* 1290; Estany de Més Amunt, 2490 m, *Azu.* 1394 bis. **13**: summit of Pic de la Portelleta and Tossa Plana de Llès, 2910 m, *Azu.* 1580; Port de Setut, 2700 m, *Azu.* 1650, 1665; Clots de la Portella de Setut, 2490 m, *Azu.* 1736, 1764; Basses de Setut, 2400 m, *Azu.* 1774; Pla d'Ingla, 2350 m, *Azu.* 1784; Pla d'Ingla-Cabana de Setut, 2320 m, *Azu.* 1812. **14**: under the Collada dels Pessons, 2650 m, *Azu.* 1885; Estany del Cap dels Pessons, 2600 m, *Azu.* 1914; Estany de les Fonts, 2500 m, *Azu.* 1973; Estany Rodó, 2400 m, *Azu.* 1980. **15**: summit of Pic de la Menera, 2774 m, *Azu.* 2038. **Chemotype II**: **9**: Serra del Roc del Rellotge, 2600 m, *Azu.* 1172. Clots de l'Estanyó, 2400 m, *Azu.* 1043. **10**: over the Estany de Més Amunt, 2540 m, *Azu.* 1281; Estany de Més Amunt, 2490 m, *Azu.* 1406, 1408, 1394. **13**: Clots de la Portella de Setut, 2490 m, *Azu.* 1756.

***Cladonia macrophyllodes* Nyl.**

Acidophilous, from 2400 to 2540 m.

Specimens examined: 9: Clots de l'Estanyó, 2400 m, Azu. 2105. 10: over the Estany de Més Amunt, 2540 m, Azu. 1295, specimen without fumarprotocetraric acid, a possible new chemotype (T. Ahti, pers. comm.).

***Cladonia mitis* Sandst. (= *Cladina arbuscula* (Wallr.) Flot. ssp. *mitis* (Sandst.) Burgaz)**

Acidophilous and neutrophilous, from 2300 to 2914 m.

Specimens examined: 1: Tarteres del Cap de la Coma, 2620 m, Azu. 59; south of Tarteres del Cap de la Coma, 2500 m, Azu. 58. 3: Coll de Juclar, 2440 m, Azu. 272, 280, 296, 312. 4: summit of Pic de la Serrera 2914 m, Azu. 320; Llac Petit dels Meners de la Coma, 2490 m, Azu. 397. 7: summit of Pic del Maià, 2614 m, Azu. 683. 9: Serra del Roc del Rellotge, 2800 m, Azu. 908, 927; 2750 m, Azu. 1141; 2600 m, Azu. 1157, 1163, 1165; 2510 m, Azu. 997, 1013, 1184, 1196; 2400 m, Azu. 1044, 2096, 2105. 10: summit of Pic de Tristaina, 2878 m, Azu. 1321; Collet de les Planes, 2700 m, Azu. 1361, 1370; over the Estany de Més Amunt, 2540 m, Azu. 1288; Estany de Més Amunt, 2490 m, Azu. 1403. 11: Collet del Cap dels Clots, 2420 m, Azu. 1449. 12: below the Canals de l'Alt, 2300 m, Azu. 1541. 13: Port de Setut, 2700 m, Azu. 1637; Portella de Setut, 2650 m, Azu. 1692, 1710; Basses de Setut, 2400 m, Azu. 1737, 1751; Pla d'Inglà-Cabana de Setut, 2320 m, Azu. 1806, 1813. 14: Estany del Cap dels Pessons, 2600 m, Azu. 1944; Estany de les Fonts, 2500 m, Azu. 1970, 1972. 15: summit of Pic de la Menera, 2774 m, Azu. 1999.

***Cladonia pleurota* (Flörke) Schaer.**

Acidophilous, from 2380 to 2500 m.

Specimens examined: 5: Coll de Finestres, 2380 m, Azu. 592. 6: Coma Estremera, 2500 m, Azu. 658. 9: Clots de l'Estanyó, 2400 m, Azu. 1049. 13: Basses de Setut, 2400 m, Azu. 1776. 14: Estany Rodó, 2400 m, Azu. 1986.

***Cladonia pocillum* (Ach.) Grognot**

Basophilous and acidophilous, 2320 to 2914 m.

Specimens examined: 2: over the Coll Petit, 2500 m, Azu. 154. 3: Coll de Juclar, 2440 m, Azu. 288, 297. 5: Torre dels Soldats, 2760 m, Azu. 563. 6: Collet de Montmalús, 2700 m, Azu. 639. 8: summit of Pic de Casamanya, 2740 m, Azu. 758. 9: summit of Pic de l'Estanyó, 2914 m, Azu. 854, 1086; Serra del Roc del Rellotge, 2510 m, Azu. 1005. 10: summit of Pic de Tristaina, 2878 m, Azu. 1218. 12: Estany Negre, 2600 m, Azu. 1525. 13: Port de Setut, 2700 m, Azu. 1618; Portella de Setut, 2650 m, Azu. 1705, 1714; Basses de Setut, 2450 m, Azu. 1767, 1771; Pla d'Inglà-Cabana de Setut, 2320 m, Azu. 1798. 14: Collada dels Pessons, 2720 m, Azu. 1843; Estany del Cap dels Pessons, 2600 m, Azu. 1918, 1937; Estany de les Fonts, 2500 m, Azu. 1948. 15: summit of Pic de la Menera, 2774 m, Azu. 2020, 2024.

***Cladonia pyxidata* (L.) Hoffm.**

Chemotype I: Acidophilous and neutrophilous, from 2160 to 2914 m.

Chemotype II: Acidophilous and neutrophilous, from 2400 to 2510 m.

Specimens examined: **Chemotype I:** **1:** Serra del Cap de la Coma, 2700 m, *Azu.* 51. **2:** Els Travessers-Costa de les Eroles, 2200 m, *Azu.* 153; 2160 m, *Azu.* 250. **4:** Llac Petit dels Meners de la Coma, 2490 m, *Azu.* 410. **9:** summit of Pic de l'Estanyó, 2914 m, *Azu.* 1166, 1084; below the summit of Pic de l'Estanyó, 2900 m, *Azu.* 1111; summit of Pic de l'Estanyó, 2800 m, *Azu.* 910; Serra del Roc del Rellotge, 2700 m, *Azu.* 946; Serra del Roc del Rellotge, 2510 m, *Azu.* 2067, 2069, 2070, 2072, 2084, 2089, 2090, 2093; Clots de l'Estanyó, 2400 m, *Azu.* 1039, 1040, 2101, 2104, 2105, 2091, 2094, 2095, 2097. **10:** summit of Pic de Tristaina, 2878 m, *Azu.* 1300, 1311, 1339; Collet de les Planes, 2700 m, *Azu.* 1365, 1369. **13:** Port de Setut, 2700 m, *Azu.* 1681; Portella de Setut, 2650 m, *Azu.* 1699, 1722, 1730; Basses de Setut, 2450 m, *Azu.* 1731, 1766; Pla d'Inglà-Cabana de Setut, 2320 m, *Azu.* 1807, 1809. **14:** below the Collada dels Pessons, 2650 m, *Azu.* 1854, 1880, 1895; Estany de les Fonts, 2500 m, *Azu.* 1952, 1969; Estany Rodó, 2400 m, *Azu.* 1978, 1980. **Chemotype II:** **9:** Serra del Roc del Rellotge, 2510 m, *Azu.* 2068; Clots de l'Estanyó, 2400 m, *Azu.* 2100. **11:** Collet del Cap dels Clots, 2420 m, *Azu.* 1446, 1447. **14:** Estany Rodó, 2400 m, *Azu.* 1976, 1982, 1984, 1988.

***Cladonia rangiferina* (L.) F.H. Wigg.**

Acidophilous, from 2340 to 2700 m.

Specimens examined: **4:** Font dels Clots de la Llosa, 2340 m, *Azu.* 415. **9:** Serra del Roc del Rellotge, 2510 m, *Azu.* 2077. **10:** Collet de les Planes, 2700 m, *Azu.* 1265, 1236.

***Cladonia subcariosa* Nyl.**

Chemotype IV (= *C. sobolescens* Nyl. ex Vain.)

Acidophilous, 2510 m.

Specimens examined: **9:** Serra del Roc del Rellotge, 2510 m, *Azu.* 2066.

***Cladonia subulata* (L.) F.H. Wigg.**

Acidophilous, from 2490 to 2914 m.

Specimens examined: **4:** summit of Pic de la Serrera, 2914 m, *Azu.* 327; Llac Petit dels Meners de la Coma, 2490 m, *Azu.* 401. **13:** Clots de la Portella Setut, 2490 m, *Azu.* 1730.

***Cladonia symphy carpia* (Flörke) Fr.**

Basophilous and acidophilous, from 2160 to 2910 m.

Specimens examined: **1:** Serra del Cap de la Coma, 2780 m, *Azu.* 111. **2:** over the Coll Petit 2500 m, *Azu.* 156, 157; Els Travessers-Costa de les Eroles, 2160 m, *Azu.* 246. **8:** Serra de Casamanya, 2400 m, *Azu.* 827. **10:** Collet de les Planes, 2700 m, *Azu.* 1359. **13:** summit of Pic de la Portelleta and Tossa Plana de Llès, 2910 m, *Azu.* 1585; Clots de la Portella de Setut, 2490 m, *Azu.* 1745. **14:** below the Collada del Pessons, 2650 m, *Azu.* 1882. **15:** summit of Pic de la Menera, 2774 m, *Azu.* 2001; Collet de la Menera, 2700 m, *Azu.* 2048, 2050.

***Cladonia uncialis* (L.) F.H. Wigg. ssp. *biuncialis* (Hoffm.) M. Choisy**
Acidophilous, from 2440 to 2914 m.

Specimens examined: 3: Coll de Juclar, 2440 m, Azu. 277, 304, 312. 4: summit of Pic de la Serrera, 2914 m, Azu. 324; Llac Petit dels Meners de la Coma, 2490 m, Azu. 389. 9: Serra del Roc del Rellotge, 2850 m, Azu. 1127; 2600 m, Azu. 986, 1165; 2510 m, Azu. 2077; Clots de l'Estanyó, 2400 m, Azu. 2096. 10: summit of Pic de Tristaina, 2878 m, Azu. 1321; Collet de les Planes, 2700 m, Azu. 1247, 1373.

***Cladonia* sp. 1**

Acidophilous, from 2650 to 2914 m.

Specimens examined: 4: Bony de l'Estany Mort, 2650 m, Azu. 440. 6: summit of Pic de Montmalús, 2781 m, Azu. 597, 622, 629. 9: summit of Pic de l'Estanyó, 2914 m, Azu. 868, 1055, 1065; below the summit of Pic de l'Estanyó, 2900 m Azu. 1100, 1109. 13: summit of Pic de la Portelleta and Tossa Plana de Llès, 2910 m, Azu. 2114, 2118, 2129.

***Cladonia* sp. 2**

Acidophilous, 2650 m.

Specimens examined: 13: Portella de Setut, 2650 m, Azu. 1713.

Discussion

Species

In the meadow region of Andorra 24 taxa have been identified: 19 species, 3 subspecies and 2 unidentified taxa. This region show a relatively high species richness, compared with Spain (68 taxa of *Cladonia* were reported by Burgaz & Ahti, 1998). The studied area has ca. 173 km² and the altitudinal range is 842 m, in front of ca. 505.000 km² and an altitudinal range of 3478 m of Spain. The presence in Andorra of *C. galindezii* (Øvstedal, 1988), considered as an endemism from the Antarctic region (Stenroos, 1993), is confirmed by eight specimens collected from five localities, between 2400 and 2910 m. Our specimens have only the primary thallus with atranorin (M), porphyritic acid (M) and methyl porphyrylate (m, occasionally present). Morphologically and chemically, our specimens are very similar to the holotype of *C. galindezii* and, in our opinion, it is only possible to assign them to this taxon (confirmed by T. Ahti and H. Sipman).

Cladonia asahinae, of the *C. chlorophaea* group, was originally described and characterized by the presence of protolichesterinic acid (Thomson, 1976). Henning (1983) found, in the type specimen, rangiformic and norrangiformic acid instead protolichesterinic acid. Brodo & Ahti (1996) reported three chemotypes for *C. asahinae*. Our specimen contains rangiformic and fumarprotocetraric acids as major substances, and norrangiformic, protocetraric and confumarprotocetraric acids as minor substances. Consequently, we can include it in the chemotype I (Brodo & Ahti, op. cit.). This species has a widespread distribution in the world. The chemotype I is the most common one and, in Europe, it is known from North and Central regions (Brodo & Ahti, op. cit.). It is here reported for the first time for the Iberian Peninsula.

C. macroceras, in the SW Europe only known from the West Pyrenees (Ahti, 1980), is abundant in the studied area. We found some specimens with atranorin, a substance that is reported as present or absent for this species (Ahti, op. cit.), but in addition, we observed that specimens with atranorin have not convirensic acid, which is normally present in specimens without atranorin. We propose the recognition of two chemotypes: I, with fumarprotocetraric acid as major substance, and protocetraric, confumarprotocetraric and convirensic acids as minor substances, and II, with atranorin and fumarprotocetraric acid as major substances, and protocetraric and confumarprotocetraric acids as minor substances. The Chemotype I is more frequent (87.3%) and has wider altitudinal range than the Chemotype II, which is less frequent (12.7%, $n = 55$) and has a small altitudinal range.

Specimens with squamules greenish brown, ascending, (0.28-) 0.50-1.63 (-3.25) mm wide, grouped in compact cushions, without podetia, and containing atranorin and homosekikaic acid as major substances, and sekikaic and 4'-O-methylnorhomosekikaic acids as minor substances, are here named *Cladonia* sp. 1.

The single unidentified specimen here named *Cladonia* sp. 2, is similar to *Cladonia* sp. 2 of Culberson *et al.* (1993). Morphologically and chemically, it is very similar to *C. symphyrcarpia*. Its chemical composition, with atranorin, norstictic and bourgeanic acids as major substances and connorstictic acid as minor substance, can be interpreted as a new chemotype of *C. symphyrcarpia* (T. Ahti, pers. comm.).

C. subcariosa is represented, in the study area, by only one specimen, devoid of podetia, containing homoheveadride (HHEV) and fumarprotocetraric acids as major substances, and protocetraric, confumarprotocetraric and convirensic acids as minor substances. This chemical composition, without convirensic acid, was described by Ahti (2000) as chemotype IV of *C. subcariosa*. We have included our specimen in this chemotype, which is recorded for the first time from Europe. It is frequent in eastern North America and eastern Asia, where it is commonly recognized as a distinct species, *C. sobolescens* Nyl. ex Vain. (= *C. clavulifera* Vain.), (Culberson *et al.*, 1993).

In *C. pyxidata*, we found the two chemotypes proposed by Ahti (2000). Chemotype I is widely distributed in the studied area, and we found convirensic acid as a minor substance, in addition to the known substances (Ahti, op. cit.). Chemotype II is poorly represented in the studied area, with homosekikaic, sekikaic ($\pm$) and fumarprotocetraric acids as major substances and protocetraric, confumarprotocetraric, convirensic and 4'-O-methylnorhomosekikaic acids as minor substances. Sekikaic acid, is a minor substance in 5 specimens, and a major substance in 3 specimens. In the neotropical specimens the sekikaic acid is only present in trace concentrations (Ahti, op. cit.). One specimen (Azu. 1982), included by us in the same chemotype, has podetia proliferating from the center of cups not from the margins of cups (Ahti, op. cit.). Chemotype II is a new report for Europe. It was earlier reported from Guatemala and Honduras (Ahti, 2000).

Table 1.-Presence and quantity of lichen substances in genus *Cladonia* from

	Bg	Rg	NRg	HHVE	Pf	MPf	H
<i>C. chlorophaea</i>							
<i>C. fimbriata</i>							
<i>C. furcata</i>							
<i>C. macroceras</i> (chemotype I)							
<i>C. pocillum</i>							
<i>C. pyxidata</i> (chemotype I)							
<i>C. subulata</i>							
<i>C. pyxidata</i> (chemotype II)							M
<i>C. pyxidata</i> (chemotype II)							M
<i>C. homosekikaica</i>							M
<i>C. subcariosa</i>				M			
<i>C. asahinae</i>		M	m				
<i>C. ecmocyna</i> ssp. <i>ecmocyna</i>							
<i>C. macrophyllodes</i>							
<i>C. macroceras</i> (chemotype II)							
<i>C. rangiferina</i>							
<i>C. sp. 1</i>							M
<i>C. symphyrcarpia</i>							
<i>C. sp. 2</i>	M						
<i>C. galindezii</i>					M	m	
<i>C. cariosa</i>							
<i>C. arbuscula</i> ssp. <i>arbuscula</i>							
<i>C. mitis</i>		M	m				
<i>C. borealis</i>							
<i>C. uncialis</i> ssp. <i>biuncialis</i>							
<i>C. diversa</i>							
<i>C. pleurota</i>							

A.- Atranorin

B.- Barbatic acid

Bg.- Bourgeanic acid

CF.- Confumarprotocetraric acid (Cph-2)

CN.- Connorstictic acid

CV.- Convirensic acid (Cph-1)

DB.- 4-O-Demethylbarbatic acid

F.- Fumarprotocetraric acid

H.- Homosekikaic acid

HHEV.- Homoheveadride

Iso.- Isousnic acid

MPf.- Methyl porphyrilate

Andorra (M, major substance; m, minor substance).

S	NH	F	P	CF	CV	N	CN	A	B	DB	Sq	U	Iso	Z	Rd	Sk
		M	m	m	m											
		M	m	m	m											
		M	m	m												
		M	m	m	m											
		M	m	m	m											
		M	m	m	m											
		M	m	m												
M	m	M	m	m	m											
m	m	M	m	m	m											
m	m	M	m	m	m											
		M	m	m	m											
		M	m	m												
		M	m	m	m			M								
		M	m	m	m			M								
		M	m	m				M								
		M	m	m	m			M								
m	m							M								
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								M								
								M								
		M	m	m								M				
												M				
									M	m		M			M	m
											M	M				
												M		M		m
												M	m	M		

N.- Norstictic acid

NH.- 4'-O-Methylnorhomosekikaic acid

NRg.- Norrangiformic acid

P.- Protocetraric acid

Pf.- Porphyrilic acid

Rd.- Rhodocladonic acid

Rg.- Rangiformic acid

S.- Sekikaic acid

Sk.- Skyrin

Sq.- Squamatic acid

U.- Usnic acid

Z.- Zeorin

Chemistry

A summary of the chemical compounds is given in Table 1. In this table the taxa are grouped according to their chemical composition. The abundance of each substance is given (M = major and m = minor). In all, 24 lichen substances, belonging to 16 chemosyndromes have been identified in the present survey. The chemosyndrome most frequent is fumarprotocetraric (M), protocetraric (m), confumarprotocetraric (m) and convirensic (m) acids. It has been found by us in *C. chlorophaea*, *C. fimbriata*, *C. furcata*, *C. macroceras* (chemotype I), *C. pocillum*, *C. pyxidata* (chemotype I) and *C. subulata*.

In the *Cladonia* species examined in the surveyed area, the fumarprotocetraric acid is always a major substance, and is present in most of the taxa (58,3%, n = 24). The cortical substances atranorin and usnic acid are present in 6 chemosyndromes and 9 taxa, and in 6 chemosyndromes and 6 taxa respectively.

Substratum and altitudinal distribution

In the calcareous mountains (numbers 2, 8 and 11, represented by 16 stations) only 5 species of *Cladonia* have been found: *C. pocillum* and *C. symphyrcarpia*, that are strongly basophilous, and *C. borealis*, *C. mitis* and *C. pyxidata* (chemotype II), that are moderately basophilous. The maximum diversity has been found in the siliceous mountains (24 taxa). We can conclude that the genus *Cladonia* is more diversified in the siliceous alpine region than in the calcareous alpine region in the studied area.

Regarding the abundance and diversity of the genus *Cladonia* growing in the siliceous mountains, the substrata most favourable are the schist and the granodiorite, and the least favourable are the black argillaceous schists (mountains 5 and 12).

In order to simplify the analysis of the altitudinal data, we selected the siliceous mountains. The siliceous substratum is the most abundant in the area of study and is represented in 67 stations from 12 mountains. Its altitudinal range is from 2300 to 2900 m.

Taking into account the altitudinal distribution, in the alpine region, four groups of taxa can be observed (Table 2):

Group 1: (2300-2900 m) present in all the elevations. For example, we found *C. chlorophaea* in exposed places within the forest of *Pinus uncinata*, in higher places we found it under the shrubs of *Rhododendron ferrugineum* and *Juniperus communis*, and in the altitudes, where those shrubs do not reach, we found it under big blocks. Similarly, *C. macroceras* (chemotype I), found in sunny and exposed situations in lower elevations, is found in cavities under rocks at the summits.

Group 2: (2300-2700 m) taxa not present in the highest stations.

Group 3: (2400-2700 m) taxa only present in middle stations.

Group 4: (2400-2900 m) taxa present with preference in the highest stations and not present in the lower stations.

Table 2. Altitudinal distribution of *Cladonia* taxa in the silicicolous stations. Presence (●) and absence (—) in the prospected stations.

	2300	2400	2500	2600	2700	2800	2900
Group 1							
<i>C. symphy carpia</i>	●	●	●	●	●	●	●
<i>C. pyxidata</i> (chemotype I)	●	●	●	●	●	●	●
<i>C. mitis</i>	●	●	●	●	●	●	●
<i>C. macroceras</i> (chemotype I)	●	●	●	●	●	●	●
<i>C. chlorophaea</i>	●	●	●	●	●	●	●
<i>C. pocillum</i>	●	●	●	●	●	●	●
<i>C. fimbriata</i>		●	●	●	●	●	●
Group 2							
<i>C. rangiferina</i>	●	●	●	●	●	—	—
<i>C. ecmocyna</i>	●	●	●	●	—	—	—
<i>C. homosekikaica</i>	●	●	●	—	—	—	—
<i>C. pleurota</i>	●	●	●	—	—	—	—
<i>C. macrophyllodes</i>		●	●	—	—	—	—
Group 3							
<i>C. cariosa</i>	—	●	●	●	●	—	—
<i>C. diversa</i>	—	●	●	●	●	—	—
<i>C. macroceras</i> (chemotype II)	—	●	●	●	—	—	—
<i>C. arbuscula</i>	—	—	●	●	—	—	—
<i>C. furcata</i>	—	—	●	●	—	—	—
<i>C. pyxidata</i> (chemotype II)	—	●	●	—	—	—	—
<i>C. subcariosa</i>	—	—	●	—	—	—	—
<i>C. sp. 2</i>	—	—	—	●	—	—	—
<i>C. asahinae</i>	—	—	—	●	—	—	—
Group 4							
<i>C. sp. 1</i>	—	—	—	—	●	●	●
<i>C. borealis</i>	—	—	—	—	●	●	●
<i>C. galindezii</i>	—	●	●	●	●	●	●
<i>C. subulata</i>	—	●	●	●	●	●	●
<i>C. uncialis</i>	—	●	●	●	●	●	●

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BIOSYSTEMATICS OF THE *DIDYMIUM IRIDIS* SUPER SPECIES COMPLEX: ADDITIONAL ISOLATES

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Abstract: Forty-six isolates referable to the *Didymium iridis* super species complex were cultured and their reproductive system determined. Thirty of the isolates were nonheterothallic and presumptive apomicts, while the remaining 16 isolates were heterothallic and found to belong to seven biological species: A0 or *D. ovoideum* (one isolates), A1 or Caribbean (five isolates), A2 or Northeastern US (one isolate), A5 or *D. megalosporum* (five isolates), A8 or Hawaii (one isolate), A9 or Costa Rican B (two isolates), and A10 or Mexican (one isolate). As such, most of the sexual isolates of this cosmopolitan complex conformed to the pattern of geographically based sibling species that are part of a more widely distributed species complex. However, the A5 and A0 groups have worldwide distributions and are primarily the basis of the *Didymium megalosporum* and *D. ovoideum* morphospecies descriptions to which they partially conform. These results suggest that the long non-calcareous stalked *Didymium* are an extremely complicated series of species complexes, each consisting of one or more biological species and countless apomictic lines with overlapping morphology. While the morphological defined species are, in a few cases, correlated with a reproductive group, the reproductive groups, in general, are not assignable to a morphologically based taxon.

Key Words: apomixis, biological species, myxomycetes, heterothallism

INTRODUCTION

Myxomycete taxonomy, at present, is based almost entirely upon sporangial morphology, with most taxonomists using a typological species concept (i.e., a species consists of individuals conforming to a constant morphological form that varies only within narrow boundaries). However, since myxomycetes are small, widely distributed organisms with a fairly restricted suite of morphological variations, it is not always easy to find the discrete morphological gaps between groups that are essential to the typological concept. Also, since little or nothing is known about the underlying genetic or developmental basis for the variations that do occur, taxonomists are left to make decisions based upon their own intuitive evaluation of these character variations (Clark 2000). This problem is compounded by the fact that many species descriptions are based on a limited number of specimens from a restricted geographical region and thus may not adequately represent the total range of variations for the population. Therefore, there is a need for experimental and population studies in this group so that a more natural system of taxonomy can be developed for the Myxomycetes.

A recent biosystematic report (Clark and Mires 1999) on the non-calcareous, long-stalked species of *Didymium* suggested that most collections of this group, could be assigned to three taxa: *Didymium iridis* (Ditmar) Fries, *Didymium ovoideum* Nann.-Brem., and *Didymium megalosporum* Berk. & Curt. *Didymium iridis* was considered to be a genetic and morphologically variable species complex consisting of a number of regionally based sibling species and a large number of apomictic lines derived from them by the suppression of meiosis. Therefore, this taxon apparently encompasses several other species whose descriptions indicate that they are morphological forms of this group. Consequently, *Didymium bahiense* Gottsberger, *Didymium nigripes* (Link) Fries, *Didymium verrucosporum* Welden and possibly several other rare species were considered to be members of this complex. *Didymium ovoideum*, with its slightly prolate sporangium and red to red brown stalk, can generally be distinguished from members of the *D. iridis* complex by its morphological as well as its genetic (non mating and plasmodial color) differences. However, the distinctive morphology of the *D. megalosporum* description (ochraceous, robust, lobate sporangia with a light brown globose collumela and nearly smooth spores) is seldom found as an entire character suite in any of the isolates and in some cases these distinctive characters are entirely missing so that the isolates grade morphologically into the *D. iridis* complex. Therefore, in an attempt to confirm these earlier observations and produce a better characterization of these taxa, additional isolates were obtained and studied.

MATERIALS AND METHODS

Spores from a sporangium, derived from either moist chamber cultures (Gilbert and Martin 1933) or field collections, were crushed on ½ CM agar (9 g Difco corn meal agar and 10 g plain agar per L of distilled water), where they germinated to produce amoebal populations and eventually plasmodia. These plasmodia were then cleaned of all fungal and most bacterial contamination by allowing them to migrate over 2% water agar (20 g plain agar per L of distilled water). The purified plasmodia, after being fed sterile rolled oats, grew into large plasmodia that were induced to sporulate by placing them in a lighted chamber (a 16:8 light:dark cycle) on 4% water agar. The resulting sporangia were then used as a source of spores to test for reproductive systems (Clark 1995). Sporangia were crushed in a small amount of water and the resulting spore slurry spotted onto a ½ CM plate. After the spores germinate, the resulting amoebae migrated away from the spots and individual amoeba were sterilely isolated under a dissecting microscope (60 X) with a fine pointed needle and placed on new ½ CM agar plates. A bacterial food source was then added to each plate which was then flooded with sterile distilled water to promote the growth of amoebal clones. If the resulting clones produce plasmodia by themselves, they were classified as nonheterothallic. However, if they did not produce plasmodia unless crossed with another clone, they were designated as heterothallic. In either case, some of the resulting plasmodia were induced to sporulate and a second generation tested for its reproductive system. A minimum of 20 clones for each generation was tested per isolate. Selected mating type testers, from each heterothallic isolate, were then crossed in all possible combinations to detect multiple allelism and biological species (Clark, 1995).

A representative sample of sporangia, for each isolate, was examined with dissecting and compound microscopes to assess morphological variations. These observations were then recorded and used to compare the morphological similarities and differences of the various isolates.

RESULTS

Reproductive systems Table 1 lists the isolates, their origin and reproductive system. Twenty-one of the *Didymium iridis* complex isolates (CR 9, CR 10, CR 11, CR 17, Ecu 1, Ecu 2, Ecu 3, Fr 2, Ha 5, Ha 6, ldn 1, ldn 2, PR 1, PR 2, SC 1, SC 2, SC 3, Tex 3, Thai 1, Thai 4, Thai 5) were found to be nonheterothallic. The 15 remaining *D. iridis* complex isolates were heterothallic and members of six different biological species. Five isolates (CR 12, CR 13, CR 14, CR 15, CR 16) were in the A1 (Caribbean) mating series, although only one mating type was recovered from the

TABLE 1. ISOLATE ORIGIN AND REPRODUCTIVE SYSTEMS

Isolate	Origin	Reproductive system ^a
<i>Didymium iridis</i> and <i>D. megalosporum</i>		
CR 9	Clark, <i>Heliconia</i> litter mc ^b , Monteverde, Costa Rica	Nonheterothallic
CR 10	Stephenson 8195, aerial litter mc, primary forest, Cahuita, CR	Nonheterothallic
CR 11	Stephenson 9135, aerial litter mc, primary forest, Cahuita, CR	Nonheterothallic
CR 12	Stephenson 9136, aerial litter mc, primary forest, Cahuita, CR	A1 ^{15,16}
CR 13	Stephenson 9141, aerial litter mc, primary forest, Cahuita, CR	A1 ^{6,17}
CR 14	Stephenson 9166, aerial litter mc, primary forest, Cahuita, CR	A1 ^{7,18}
CR 15	Stephenson 9134, aerial litter mc, primary forest, Cahuita, CR	A1 ¹⁵
CR 16	Stephenson 9144, aerial litter mc, primary forest, Cahuita, CR	A1 ¹⁵
CR 17	Stephenson 12128, canopy litter mc, montane forest, Monteverde	Nonheterothallic
CR 18	Stephenson 12129, litter mc, dry coastal forest near Santa Rosa NP	A9 ¹
CR 19	Stephenson 12130, litter mc, dry coastal forest near Santa Rosa NP	A9 ^{1,2}
Cur 1	Clark, plant litter mc, Curacao, Netherlands Antilles	A5 ^{5,9}
Ecu 1	Stephenson 9739, cloud forest Macquipucuna Reserve, Ecuador	Nonheterothallic
Ecu 2	Stephenson 9908, cloud forest Macquipucuna Reserve, Ecuador	Nonheterothallic
Ecu 3	Stephenson 9902, cloud forest Macquipucuna Reserve, Ecuador	Nonheterothallic
Fr 2	Meyer 16883, Langon ZI, France	Nonheterothallic
Ha 2	Landolt, soil mc, Kipuka Puaua Bird Park, Hawaii Volcanoes NP	A5 ^{6,7}
Ha 3	Landolt, soil mc, Sacred Falls Trail near Hauula, Hawaii	A5 ^{1,8}
Ha 4	Landolt, soil mc, Kipuka Puaua Bird Park, Hawaii Volcanoes NP	A8 ^{1,2}
Ha 5	Landolt, soil mc, Manoa Falls Trail Honolulu, Hawaii	Nonheterothallic
Ha 6	Stephenson 7984, forest floor litter mc, Hawaii	Nonheterothallic
Idn 1	Clark, banana litter mc, Ngampel/Kediri, E. Java, Indonesia	Nonheterothallic
Idn 2	Clark, banana litter mc, Donayan/Kediri, E. Java, Indonesia	Nonheterothallic
Mex 4	Stephenson 12629, forest floor litter mc, El Eden, Yucatan, Mexico	A10 ^{1,2}
PR 1	Stephenson 8033B, forest litter mc, El Verde, Puerto Rico	Nonheterothallic
PR 2	Clark, secondary forest litter mc, El Verde, Puerto Rico	Nonheterothallic
SC 1	Stephenson 12657, magnolia flower mc, Summerville, S.C.	Nonheterothallic
SC 2	Stephenson 12697, old inflorescence mc, James Island, S.C.	Nonheterothallic
SC 3	Stephenson 12712, old rose petals mc, Summerville, S.C.	Nonheterothallic
Tex 3	Stephenson 12257, litter mc, Sotal Grassland Big Bend NP	Nonheterothallic
Thai 1	Stephenson 9168, litter mc, Kanchanaburi Falls, Thailand	Nonheterothallic
Thai 2	Stephenson 9159, litter mc, Kanchanaburi Falls, Thailand	A5 ^{2,10}
Thai 3	Stephenson 9147, litter mc, Kanchanaburi Falls, Thailand	A5 ¹¹
Thai 4	Stephenson 9131, litter mc, Kanchanaburi Falls, Thailand	Nonheterothallic
Thai 5	Stephenson 9160, litter mc, Kanchanaburi Falls, Thailand	Nonheterothallic
WV 1	Stephenson 11273, corn litter mc, north central W. Virginia	A2 ⁵
<i>Didymium ovoideum</i>		
CR 1	Stephenson 8190, aerial litter mc, near Irazu, Costa Rica	Nonheterothallic
CR 2	Stephenson 12132, ground litter mc, near Santa Rosa NP	Nonheterothallic
CR 3	Stephenson 12131, ground litter mc, near Santa Rosa NP	Nonheterothallic
Idn 1	Clark, banana litter mc, Moloroto/Kediri, East Java, Indonesia	Nonheterothallic
Idn 2	Clark, banana litter mc, Nqayan/Kediri, East Java, Indonesia	Nonheterothallic
Idn 3	Clark, banana litter mc, Semanpit/Kediri, East Java, Indonesia	Nonheterothallic
Idn 4	Clark, banana litter mc, Kedaton, Bandor Lampung, Sumatra	Nonheterothallic
Idn 5	Clark, banana litter mc, Kedaton, Bandor Lampung, Sumatra	Nonheterothallic
Tenn 1	Stephenson 12729, forest floor litter mc, GSMNP, Tennessee	A1 ²
Tenn 2	Schnittler 15835/5, leaf litter, GSMNP, Tennessee	Nonheterothallic

^a Reproductive systems = nonheterothallic or heterothallic; the mating series of the heterothallic isolates are indicated with an A and number (i.e., A1, A2, etc.), and the alleles are indicated by superscript numbers.

^bmc = moist chamber culture.

CR 15 and CR 16 isolates. These highly skewed ratios (the second mating type can generally be recovered if enough clones are isolated) are fairly common in the myxomycetes, although no definite explanation for this phenomenon has yet been determined (Clark 1997). All five of these isolates are from the Cahuita area on the Caribbean coast of Costa Rica and are compatible with the common biological species (A1) of the Caribbean region (Clark and Landolt 1993). The CR 12 isolate had two new mating type alleles (A1¹⁵ and A1¹⁶), CR 13 had one new (A1¹⁷) and one old (A1⁶) allele, CR 14 had one new (A1¹⁸) and one old (A1⁷) allele, and both the CR 15 and CR 16 isolates had a single A1¹⁵ allele. The WV 1 isolate was compatible with the A2 mating series of the Northeastern region of the USA (Clark and Stephenson 1990) and only a single new allele (A2²) was found in this isolate. Five isolates (Cur 1, Ha 2, Ha 3, Thai 2, Thai 3) were members of the world wide A5 mating series, although again only a single mating type allele was found in the Thai 3 isolate. Two new alleles (A5⁶ and A5⁷) were recovered from the Ha 2 isolate, one new (A5⁸) and one old (A5¹) allele from the Ha 3 isolate, one new (A5⁹) and one old (A5⁵) allele from the Cur 1 isolate, one new (A5¹⁰) and one old (A5²) allele from the Thai 2 isolate, and a single (A5¹¹) allele from the Thai 3 isolate. The Ha 4 isolate was found to represent a new biological species (Hawaii), since it did not mate with any of the known mating series tester clones, and it has two mating types (A8¹ and A8²). CR 18 and CR 19 isolates also are members of a new biological species (Costa Rican B) since they were also genetically isolated from the rest of the complex. Both of these isolates are derived from litter collected in a dry coastal forest near the Santa Rosa National Park in Costa Rica and are thus apparently sympatric with the widespread A1 (Caribbean) and restricted A4 (Costa Rica A) biological species. The CR 18 isolate has a single mating type (A9¹), while CR 19 has two (A9¹ and A9²) mating types. The Mex 4 isolate is also a representative of a new biological species since it was reproductively isolated from all of the other sexual isolates, and it has two mating types (A10¹ and A10²). Nine (CR 1, CR 2, CR 3, Idn 1, Idn 2, Idn 3, Idn 4, Idn 5, Tenn 2) of the *Didymium ovoideum* isolates were found to be nonheterothallic and the tenth (Tenn 1) was heterothallic with a single mating type (A0²) compatible with the heterothallic Virginia/West Virginia series (Clark and Stephenson 1994).

Morphology The morphology of each of the different reproductive groups is examined separately.

A1 (Caribbean) sibling species Isolates CR 12, CR 13, CR 14, CR 15 and CR 16 are members of the A1 sibling species and were all isolated from the Cahuita area of southeastern Costa Rica. Four of these isolates have an almost identical morphology, with the CR 16 isolate being somewhat different. They all display slightly depressed globose sporangial heads and long, light orange-brown stalks, although the CR16 sporangial head was somewhat lobose. The sporangial heads, in all five isolates, have thin colorless peridial membranes covered with white stellate calcium carbonate crystals (in the more poorly developed sporangia the lime crystals are lumpy and grainy). The columellae are white (lime covered), discoid to ovoid in shape, and the umbilicus is closed in all of the isolates except CR 16. The capillitium consists of a network of slender branching and anastomosing colorless to pale brown-tinged threads and the 7-8 μ diam. spores are brown and covered with small to minute warts. All five of these isolates have the standard brown plasmodium of the complex.

A2 (Northeastern US) sibling species The single isolate (WV 1) of this sibling species has a slightly depressed globose sporangial head and intermediate to long light orange-brown colored stalks. The thin colorless peridial membrane is covered with white stellate lime crystals and the white columella is thinly discoid with a closed umbilicus. This isolate has a capillitium network of fine colorless threads and brown 9 μ diam. spores covered with minute warts. This isolate also has the standard brown plasmodium.

A5 (*D. megalosporum*) sibling species These five isolates (Cur 1, Ha 2, Ha 3, Thai 2, Thai 3) are similar in that they all have robust, slightly depressed, globose sporangial heads and intermediate to long, light to medium orange-brown stalks. The thin colorless peridial membranes are covered with white stellate (lumpy and grainy in poorly developed sporangia) lime crystals and the ovoid to globose columellae have a closed umbilicus and are generally white with a yellowish tinge (most Ha 2 and Ha 3 sporangia generally lack the yellowish tinge). The capillitium consists of a network of colorless to pale brown-tinged threads and the brown 7-9 μ diam. spores have a

varied ornamentation, with the Ha 2, Ha 3, and Cur 1 isolates having minute warts and the Thai 2 and Thai 3 isolates having small to distinct warts. These isolates differ from previously reported A5 isolates in their lack of lobate sporangial heads and the presence of more distinct spore ornamentation in the Thai 2 and Thai 3 isolates (Clark and Mires, 1999). Four of these five isolates have the standard brown plasmodium, but Ha 2 has a light tan (cream) colored plasmodium that is correlated with its light orange-brown colored stalk.

A8 (Hawaii) sibling species Ha 4 is the single isolate of this new sibling species. This isolate has a slightly depressed globose sporangial head with an intermediate length light orange-brown colored stalk. White stellate lime crystals cover the thin colorless peridial membrane and the white discoid columella, which has a closed umbilicus. The capillitium is a network of thin colorless threads and the spores are brown, minutely warted and $9\ \mu$ in diameter. This isolate has the standard brown colored plasmodium of the complex.

A9 (Costa Rican B) sibling species These two isolates (CR 18, CR 19) have very similar morphology, with depressed globose sporangial heads and intermediate length medium orange-brown colored stalks. White stellate to lumpy lime crystals cover the thin light brown peridium and the globose to discoid columella has a closed umbilicus. The columella varies from white to brown depending upon the presence or absence of lime. The capillitial network consists of thin colorless to light brown-tinged threads and the spores are brown, minutely warted and $7-8\ \mu$ in diameter. These isolates also have a brown plasmodium.

A10 (Mexican) sibling species This isolate (Mex 4) has a depressed globose sporangial head and long to intermediate length medium orange-brown colored stalks. Stellate white lime crystals cover the thin hyaline peridium and the brownish (little to no lime) discoid columella has a closed umbilicus. The capillitium is a network of thin hyaline threads and the brown minutely warted spores are $7-9\ \mu$ in diameter. The plasmodium is the standard brown plasmodium of the complex.

Nonheterothallic *D. iridis* complex isolates This is a more diverse group of isolates; however, they can still be separated into several fairly coherent morphological units. Ten of the isolates (CR 10, CR 11, Fr 2, Ha 5, Idn 1, PR 2, SC 1, SC 2, SC 3, Thai 3) form a loose group of similar sporangia with three subgroups. The first subgroup consists of the CR10, CR 11, PR 2, SC 1, and SC 2 isolates, all of which have slightly depressed globose sporangial heads and intermediate to long, light (very light in CR 10) orange-brown colored stalks. They also have thin colorless peridial membranes covered with white stellate (grainy when poorly developed) lime crystals and white discoid (nearly globose in SC 1) columellae with open to partially open umbilica. The capillitium is a network of thin colorless to pale brown-tinged threads and the spores are brown, $7-10\ \mu$ diam. and minutely warted. The Ha 5, Idn 1, SC 3, and Thai 5 isolates comprise a second subgroup that differs from the first subgroup in having dark orange-brown stalks and a closed umbilicus (Ha 5 is slightly open). The Fr 2 isolate, which is the sole member of the third subgroup, also differs from the first subgroup in having a white to brownish yellow (lacking lime) columella and more prominently warted spores. Six of the isolates of this group have the standard brown plasmodium, but the plasmodium of CR 10 is cream colored and that of Idn 1 is yellowish tan. CR 10 has a very light colored stalk that is correlated with its plasmodial color, but the Idn 1 stalk is not light colored, possibly due to slow sporangial development (Clark and Mires 1999). The SC 1 and SC 2 plasmodia also differed in color (a light brown that correlates with their light colored stalk) but are most noticeably different in terms of their smaller size and more rapid fruiting.

A second group of isolates was based on a cluster consisting of the CR 17, Ecu 2, Ecu 3, and Idn 2 isolates that have slightly depressed globose sporangial heads and long, dark orange-brown colored stalks. Their peridial membranes are thin, colorless and covered with white stellate lime crystals and their dark to yellowish tinged columellae are ovoid to globose and have a closed umbilicus. The capillitial network consists of colorless to pale brown tinged threads and the minutely warted spores are brown and $7-10\ \mu$ diam. The Thai 1 and Thai 4 isolates differ from this first cluster in having darker brown more distinctly warted spores. The six isolates, of this group, all have a standard brown plasmodium.

Finally, the Ecu 1 and Tex 3 isolates each have a fairly unique morphology. The Ecu 1 isolate has a depressed to flattened sporangial head and long, dark orange-brown stalks. Its peridial membrane is thin, colorless and covered with white stellate lime crystals and its white columella is a thin plate in a wide shallow umbilicus. The capillitial network consists of thin hyaline threads and the brown 8-9 μ diam spores are minutely warted. The brown plasmodium is standard for the complex. The Tex 3 isolate has a globose to slightly depressed globose sporangial head and short to intermediate light orange-brown stalks. The thin, colorless peridial membrane is covered with white stellate lime crystals and its "columella" consists of a basal plate without an umbilicus. However, it has a standard capillitial network of colorless threads and brown 9 μ diam. minutely warted spores. Tex 3 is also unique in that it has a light yellow colored plasmodium that correlates with its light colored stalk.

Heterothallic *D. ovoideum* isolate The Tenn 1 isolate sporulated poorly in culture but produced morphologically standard sporangia. The globose to prolate sporangial heads are supported by intermediate to long moderate red-brown stalks with a closed umbilicus. The hyaline peridial membrane is covered with white lime crystals and the capillitial consisted of thin hyaline to light brown-tinged threads. The columella is globose and light yellow, while the sparsely and minutely warted 8-12 μ diam spores are light brown in color.

Nonheterothallic *D. ovoideum* isolates These nine isolates (CR 1, CR 2, CR 3, Idn 1, Idn 2, Idn 3, Idn 4, Idn 5, Tenn 2) are generally similar, with globose (varying from slightly prolate to slightly sub-globose) sporangia with long to intermediate dark red-brown colored stalks (Idn 5 stalks can also be light red-brown colored) and a generally closed umbilicus. White lime covers the colorless peridia and the capillitial network consists of colorless to pale brown-tinged threads, with the Idn 3 isolate having slightly thicker threads. The columellae are globose and light yellow in isolates CR 1, CR 3 and Tenn 1; globose and white in Idn 1, Idn 3, Idn 4, and Idn 5; discoid and light brown in Idn 2 and plate like (with an open umbilicus) and light yellow in CR 2. Isolates CR 2, Idn 3 and Idn 4 also have slightly spiny columellar surfaces. The spores of all isolates are brown, 8-10 μ diam and minutely warted (CR 2, Idn 2 and Idn 4 are somewhat more distinctly warted). Seven of these *D. ovoideum* isolates have the bright yellow colored plasmodium characteristic of this species. However, Idn 5 has a light yellow colored plasmodium that correlates with its lighter colored stalk, and the Tenn 1 has an orangish-yellow plasmodium. These are the first plasmodial color variations reported for this species.

DISCUSSION

The non-calcareous long-stalked *Didymium* species are a taxonomically difficult group and while cultural studies have helped sort out natural taxa (Betterley and Collins 1983, Clark and Mires 1999), there is still a problem in delimitating the various groups due to overlapping morphological characters. This culture study has helped resolve some of these problems, but it has also added new difficulties in terms of even more overlapping morphological variations among the taxa.

The *Didymium iridis* species complex, as defined by Clark and Mires (1999), contains the *D. iridis*, *D. bahiense*, *D. nigripes* (in part) and *D. verrucosporum* morphospecies. This study supports this concept of a morphologically variable cosmopolitan species complex consisting of many biological sibling species, generally allopatrically distributed, and numerous apomictic clonal lines. The five (CR 12, CR 13, CR 14, CR 15, CR 16) A1 (Caribbean) sibling species isolates would be identified as being in the *D. iridis* or *D. bahiense* morphospecies on the basis of their morphology. Also, the A2 (Northeastern USA) sibling species isolate (WV 1) and the new A8 (Hawaii) sibling species isolate (Ha 4) would both be keyed out as *D. bahiense*. The two isolates (CR 18, CR 19) of the new A9 (Costa Rican B) sibling species, which is sympatric with the A1 (Caribbean) and A4 (Costa Rican A) sibling species, are quite variable in culture and could be identified as either *D. iridis*, *D. bahiense* or *D. nigripes* depending upon the sporangium examined.

The new A10 (Mexican) sibling species isolate (Mex 4) would most likely key out as a somewhat aberrant *D. nigripes*. The first group of nonheterothallic isolates (CR 10, CR 11, Fr 2, Ha 5, Idn 1, PR 2, SC 1, SC 2, SC 3, Thai 5) generally conform to a *D. bahiense* or *D. iridis* morphology,

dependent upon their columellar characteristics. However, the sporangia produced in culture by the Fr 2 isolate, which is derived from a collection identified as *D. verrucosporum* by Meyer (# 16883), are somewhat outside of the *D. bahiense* variation due to the fact that the spores are more heavily warted and the columella is often brownish due to a lack of lime. However, this isolate, which is the first collection identified as *D. verrucosporum* to be cultured, no longer conforms to the *D. verrucosporum* description in that the heads are not nodding, the stalk is light colored, the capillitium is colorless and more anastomosing, and the columella is not always white. The second group of nonheterothallic isolates (CR 17, Ecu 2, Ecu 3, Idn 2, Thai 1, Thai 4) would key out as *D. nigripes* (Ecu 2, Ecu 3, Idn 2, Thai 1) or *D. megalosporum* (Cr 17, Thai 1) if an identification was forced. However, the remaining two nonheterothallic isolates would not fit any species descriptions although they are closest to *D. iridis* (Ecu 1) and *D. bahiense* (Tex 3).

The *Didymium megalosporum* species complex as defined by Clark and Mires (1999) is based on the A5 biological species, which has a world wide distribution and contains a number of isolates having some combination of the key characters of the *D. megalosporum* morphospecies description. These characters, which are not all present in any single isolate, are the robust lobate sporangial head, a light brown-tinged globose to discoid columellae, and nearly smooth spores. The yellowish sporangial heads and rugose columellae of the morphospecies description are not found in any cultured isolates. In this study, all of the A5 isolates (Cur 1, Ha 2, Ha 3, Thai 2, Thai 3) lacked the lobate sporangial head form and nearly smooth spores (they were minutely warted except for the Thai 2 and Thai 3 isolates, which were moderately warted), but they were robust and had yellowish brown columellae (sometimes lacking in the Ha 2 and Ha 3 isolates). The Ha 2 isolate had a light tan colored plasmodium (the first plasmodial color variant in the A5 biological species) and a concurrent lighter stalk. The second group of nonheterothallic isolates contained two isolates (CR 17, Thai 1) that were very similar to the A5 isolates, with the Thai 1 also having moderately warted spores. These A5 isolates (and associated nonheterothallic isolates), which lack (except for CR 17) a lobate sporangial head and have warted spores, morphologically integrate into the *D. iridis* species complex, thus making it even more difficult to separate these two complexes on the basis of morphology.

The *Didymium ovoideum* species complex (Clark and Mires 1999) has been defined by its mating system (sympatric and genetically isolated from the rest of the heterothallic isolates of the non-calcareous long-stalked complex), bright yellow plasmodium and associated red brown colored stalk, and prolate sporangial head. The columella is also white to yellowish, globose and sometimes having a spiny surface to which the capillitium is attached. The single heterothallic isolate (Tenn 2) has the standard morphology of this morphospecies and is compatible with the West Virginia/Virginia sibling species, with which it shares the characteristic of highly skewed mating type ratios. The nine nonheterothallic isolates (CR 1, CR 2, CR 3, Idn 1, Idn 2, Idn 3, Idn 4, Idn 5, Tenn 1) in this study generally have the bright yellow plasmodium (Idn 5 has a light yellow plasmodium and that of Tenn 1 is orangish-yellow), associated red brown stalk and the generally prolate sporangial head shape of this complex. However, their columellae varied in shape from globose or discoid to a flattened basal plate and in color from white to yellowish or brownish tinged. Thus, these nonheterothallic isolates, the first reported for this species, are less distinctive than the previously reported heterothallic isolates (Clark and Stephenson 1994, Clark and Mires 1999).

The Tex 3 nonheterothallic isolate, with its lack of a columella and light yellow colored plasmodium, is fairly unique and does not fit into any of the species complexes. Therefore, pending further similar collections, it is considered to be a nonheterothallic clonal line that has accumulated some distinctive characteristics and is thus an unnamed micro-population outlier of this group.

The nonheterothallic SC1 and SC 2 isolates, which were isolated from inflorescence moist chambers, both had small rapidly sporulating plasmodia. Apparently, these clonal isolates, of the *Didymium iridis* species complex, are adapted to the ephemeral nature of this microhabitat, which supports the contention that the clonal lines in these complexes are local populations adapted to local conditions.

The results of this study support the idea that the *Didymium iridis* species complex is a morphologically variable worldwide cosmopolitan taxon consisting of many sexual sibling species and numerous non-sexual clonal lines. The sibling species are generally geographically based allopatric populations (Clark and Stephenson 1990), although there are at least three sympatric sibling species in Costa Rica. The non-sexual clonal lines are present in all areas and are apparently restricted, in most cases, to small local populations. Also, all of these genetically isolated sibling species and clonal populations share a rather limited suite of morphological variations and thus can not be separated on morphological grounds (Clark and Mires 1999). Thus, a number of morphospecies - *Didymium bahiense*, *D. iridis*, *D. megalosporum*, *D. nigripes*, *D. verrucosporum*, and to a lesser extent *D. ovoideum* - morphologically integrate into each other. In fact, *D. bahiense*, *D. iridis* and *D. verrucosporum* sporangia can be found in different sibling species and clonal lines and are, therefore, forms of the *D. iridis* complex and are not separate taxa. Also, a number of rare taxa such as the recently described (Ing 2000) *Didymium canariense* Ing are almost certainly clonal biotypes of the *D. iridis* complex that display a limited morphological distinctness. The sexual isolates of the *Didymium megalosporum* species complex, however, are genetically isolated and sympatric with the *D. iridis* complex sibling species and also has some morphological distinctions. Therefore, it is a separate, but closely related species complex. Sporangia of the *D. nigripes* morphospecies, when cultured, have been found to be forms (often displaying poor development) of the *D. iridis* complex. However, this taxon is very difficult to grow in culture (a few sporangia produce a red-brown plasmodia that have not yet sporulated) and there remains the possibility that *D. nigripes* will (in part) turn out to be a separate taxon similar to *D. magalosporum*. *Didymium ovoideum*, on the other hand, is morphologically as well as genetically divergent from the *D. iridis* complex, although the morphological separation is sometimes rather minor and a close examination is required in order for the differences to be detected. These overlapping species complexes (each consisting of one or more biological species and numerous apomictic lines), thus produce an extremely complicated super species complex in which there is an apparent complete morphological integration.

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Developmental morphology and ultrastructure of *Pestalotiopsis maculans*

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Abstract

The development of conidiomata in *Pestalotiopsis maculans* (Corda) Nag Raj was studied using light and transmission electron microscopy. Light microscopic studies showed the presence of pycnidial conidiomata in culture whereas the fungus is known to produce only acervular conidiomata on host leaves. One of the interesting observations is the ultrastructure of the conidial wall in the coloured cells as well as the basal and apical hyaline cells with the appendages. This investigation, which has included ultrastructural details, has thrown new light on the development of the conidiomata of *P. maculans*.

Key words: Coelomycetes, Conidiomata, conidium ontogeny, structure, appendages.

Introduction

In view of the variability and diversity in the form of the Coelomycete conidiomata it is no easy task to accommodate them satisfactorily in a system of classification based on conidiomata. One finds acervular, stromatic and pycnidial conidiomata in the species of *Colletotrichum* in culture. Similarly, conidiogenous cells are formed directly from the mycelium in culture though such fungi are known to produce pycnidial conidiomata in nature (Subramanian and Reddy 1974; Baxter 1981; Baxter *et al.*, 1985). Therefore, as more and more data to this effect becomes available, the distinction between Hyphomycetes and Coelomycetes may be abandoned because of the presence of intermediary stages between Hyphomycetes, acervular, stromatic and cupulate conidiomata. In the present investigation, it was observed that *P. maculans* produced pycnidial conidiomata in culture and acervular conidiomata on its natural host. The various stages of development of the conidiomata were investigated in culture and they also resembled that of a typical pycnidial conidioma which are already studied. The developmental morphology of the conidiomata in *P. maculans* is described here.

Pestalotiopsis maculans was reported on Custard apple from India (Rao, 1968). In the present study, the fungus was isolated from fallen leaves of *Cinnamomum wightii*.

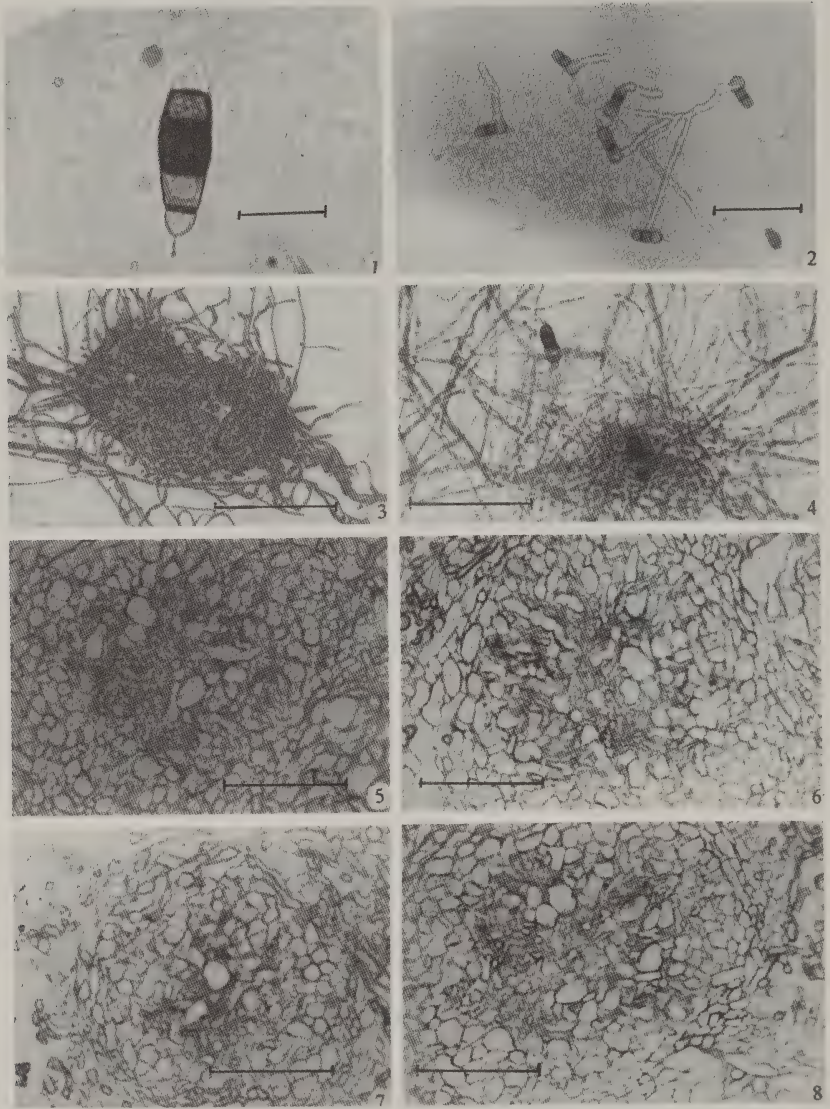


Fig. 1. Mature conidium. Bar = 12.5 μ m. 2. Germinating conidia producing germ-tube from the lowermost Median Cell. Bar = 50 μ m. 3&4. Symphogenous method of primordial formation. 3 Bar = 25 μ m. 4 = 100 μ m. 5-8 Sections of the primordia showing pseudoparenchymatous tissue. Bar = 50 μ m

Materials and methods

Pestalotiopsis maculans (Corda) Nag Raj was isolated from leaf of *Cinnamomum wightii* collected in Kodaikanal, Tamil Nadu, India. Cultures of *P. maculans* were grown on Oat meal agar (OMA) and Potato dextrose agar (PDA) in petri dishes at room temperature (28°C). The initial stages of the development of conidiomatal primordia were studied by slide cultures (Riddell, 1950). For germination studies, conidia were collected aseptically from the teased out conidiomata in 1% glucose solution and allowed to germinate in cavity slides. Slides were kept at room temperature (28°C) and were examined every 5 h for 36 h to study germination.

To study the development of conidiomata, selected conidiomata with agar were trimmed into 2mm square blocks and fixed in 2% glutaraldehyde in 0.1 M phosphate buffer (pH 7.2) for 2h at room temperature (27°C) and 1h at 4°C and post fixed for 12h in 1% Osmium tetroxide. The specimen was washed in series of acetone solutions followed by 2-3 changes in fresh Spurr (4-Vinylcyclohexane dioxide (VCD) 10 mL, Resin 736 (Der) 4 mL, 2-Nonen-1- Y1 Succinic Anhydride (NSA) 26 mL, 2-Dimethylamino ethanal (DMAE) 0.4 mL. (In the ratio of 3:1 (Acetone:Spurr) for 6h, followed by two changes with absolute Spurr mixture for 24h) each lasting for 8h and polymerised in fresh Spurr at 70°C for 8 h. The samples infiltrated with the resins were transferred to a vacuum chamber for 1h for complete removal of any air bubbles. Thin sections (0.5 µm) were cut from these blocks and stained with 1% aqueous toluidine blue to study the development of conidiomata and conidiogenesis under light microscopy. Ultrathin sections were collected on copper grids (400 mesh). The excess water in the grids was removed by a filter paper. Photomicrographs were taken by using Nikon "Labophot" (model HFX 11) carl zeiss microscope. TEM photographs were taken in a Philips CM 10 TEM.

Results

Description of the fungus in culture

Conidiomatal pustules, punctate, subglobose, black, 100-120 µm diam. conidia 5-celled, fusiform to clavate, versicoloured, upper two median cells dark brown and lower median cell light brown, tapering, 19-25 (24) x 6-8 (7.2) µm. Apical cells conic to cylindric, hyaline, with two to three appendages, 16-17 µm long. Median cells 10-15.5 (14.5) µm long. Basal cells long conic, hyaline, with a basal appendage, 4.2-5 (4.2) µm long (Fig. 1).

Germination of conidia

Conidial germination occurred after 12 h in 1 % sucrose solution. The conidia became swollen, resulting in the breakage of outer wall in the lower most median cell, and the germ tube emerged. The germ tubes arise mainly from the lower most median cells and rarely from the basal hyaline cells also. Only one germ tube arises from each cell (Fig. 2).

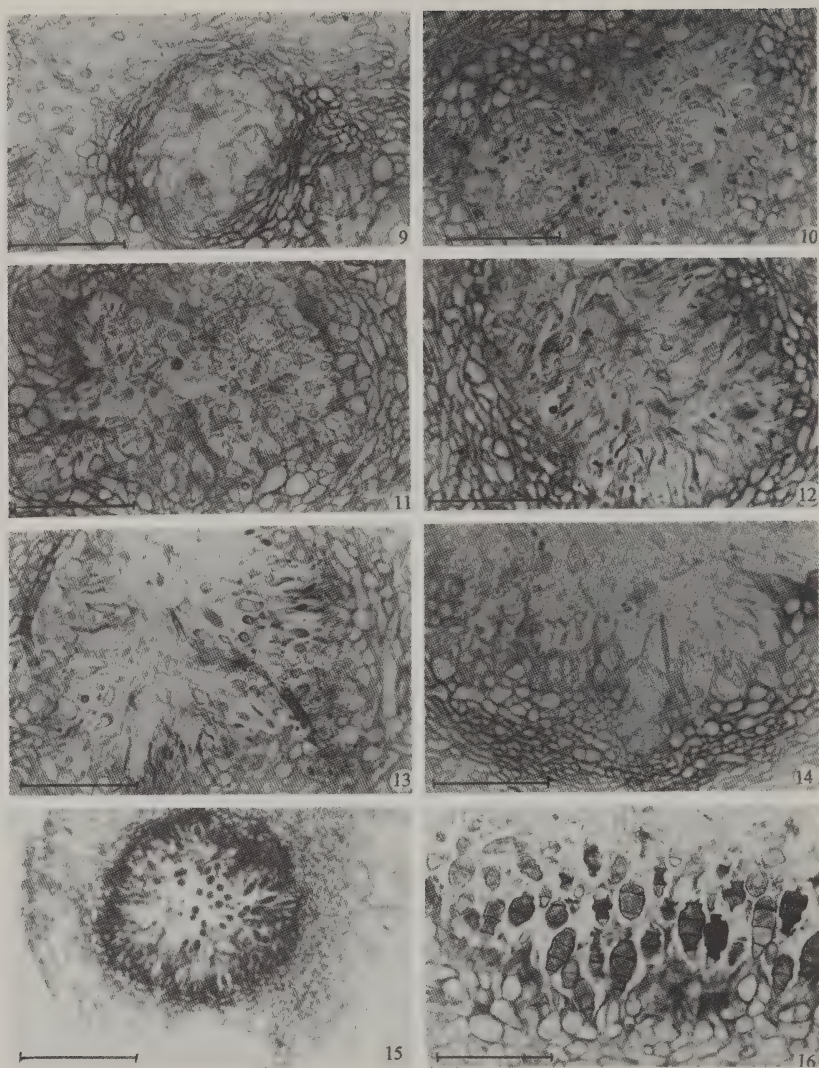


Fig. 9. Section through young primordium showing the formation of central cavity by dissolution of cells at the centre. Bar = 50 μ m. 10. Section through young primordium showing the formation of central cavity. Bar = 50 μ m. 11. Section of young conidioma showing the initially formed conidia. Bar = 50 μ m. 12. Section through young primordium showing gelatinization of central cells. Bar = 50 μ m. 13-14. Sections through young primordia showing formation of central cavity. Bar = 50 μ m. 15. Vertical section of mature pycnidium. Bar = 100 μ m. 16. Vertical section of conidioma showing temporary conidiogenous cells. Bar = 50 μ m.

Development of conidiomatal initial

The conidiomatal initials were first evident as small knots of fungal hyphae. The pycnidial primordium is initiated by the interweaving of young hyphal branches to form a network, which is at first loosely interwoven but later became compact knot-like. During further development, the primordial initial undergoes repeated divisions which results in the formation of a spherical mass of pycnidial primordium (Figs. 3 and 4). This type of pycnidial initial is named as "symphogenous". Initially the cells constituting the primordium are spherical to subspherical and are hyaline which stain deeply when compared to the cells of the surrounding hyphae. Shortly after the formation of somewhat spherical to subspherical primordium, which is made up of loosely arranged pseudoparenchymatous cells, the formation of the central cavity was observed.

The earliest stage of conidiomatal development seen in sectioned material consists of small pseudoparenchymatous mass of tissue. The primordium is almost spherical comprising a compact cluster of thick - walled cells (Fig.5). During further development the primordium continuously increased in size by continued transverse and longitudinal divisions of the cells. As the primordial development progresses, the several layers of the primordium are differentiated into morphologically distinct layers. The outermost two or three layers were pseudoparenchymatous with thick, lightly pigmented walls, which form the outer wall layer of the conidiomata. Inside this outer wall three to four compact layers of cells were present (Figs. 6-8).

Formation of sporogenous tissue

The central cells in the primordium showed signs of schizogenous and lysigenous activity to form the central cavity (Figs. 6-8). The remnants of the disorganised cells at the centre of the primordium were visible in many transverse sections of the pycnidial conidiomata (Figs. 9-12). The remaining portions of the cells often gelatinize and fill up the cavity with the mucilagenous matrix. (Fig. 12). Further developmental stages showed the formation of the conidium simultaneously with the cavity formation. As the conidia mature they are released from the conidiogenous cells and fill up the cavity (Figs. 13 and 14). The formation of conidiogenous cells inside the cavity of the conidiomata is another interesting feature studied in the species of *Pestalotiopsis*. It was the pioneering work of Punithalingam (1979) who studied in detail, the process of conidiation in *Ascochyta* species in culture, which produced both temporary and permanent conidiogenous cells inside the pycnidium. The earlier workers who studied the development of pycnidia in culture examined only mature pycnidia but the processes of conidial formation during the initial stages of pycnidium development were not given due consideration. It was Punithalingam (1979) who made a thorough investigation on the various stages of conidiation inside a pycnidial conidioma. According to him, the cells lining the pycnidial cavity produce conidia initially only to get sloughed off as soon as their function is over. Once a layer of conidiogenous cells lining the pycnidial cavity is completely dislodged, a new layer of cells lining the cavity functions as conidiogenous cells. Thus, the processes of conidiation and dislodgement are repeated continuously. These are the two main processes by which the pycnidial cavity gradually increases in size and becomes filled with conidia and sloughed off conidiogenous cells. This is another way adopted by nature to produce a greater number of conidia inside a pycnidium where the space is very limited.

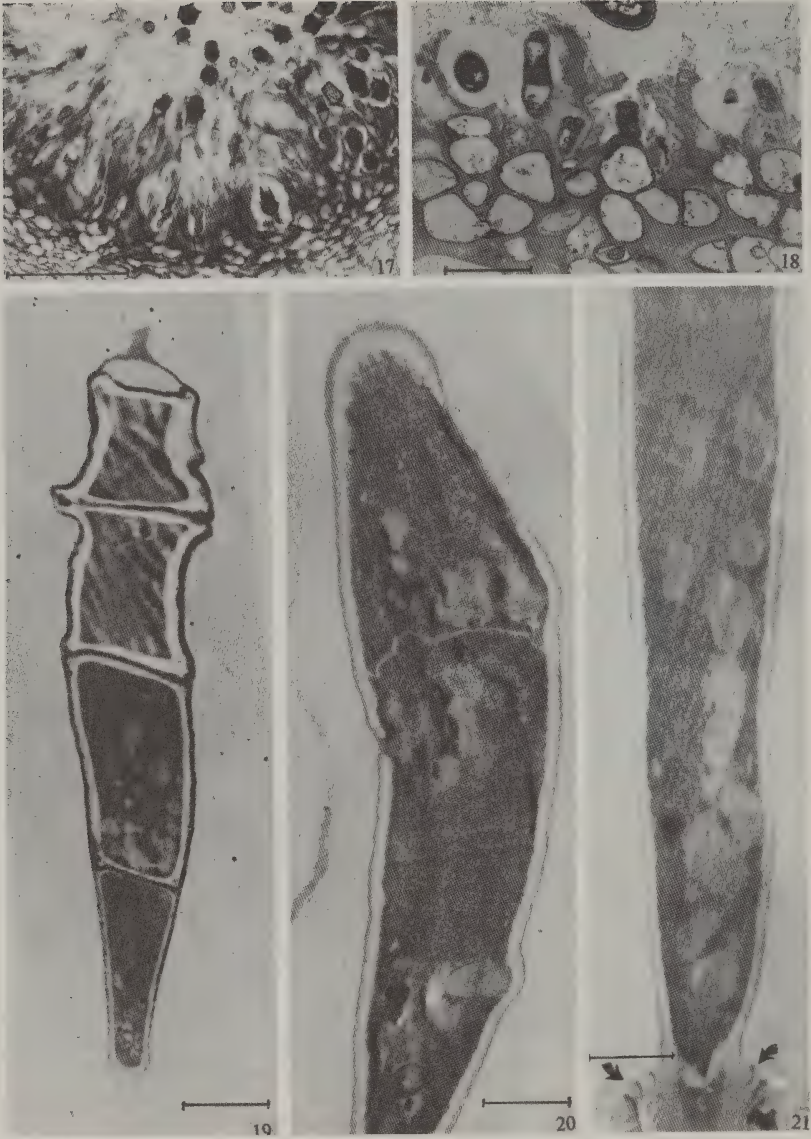


Fig. 17. Section of the conidioma showing gelatinization of temporary conidiogenous cells. Bar = 50 μ m. 18. TEM. Section showing young conidia and conidiogenous cells. Bar = 1 μ m. 19. TEM. Longitudinal section of a mature conidium. Bar = 2 μ m. 20. TEM. Section of a young conidium showing the formation of a transverse septum (arrow). Bar = 2 μ m. 21. Section through young conidium showing the annellides. Note annellations (arrows). Bar = 2 μ m.

It is very interesting to note that similar processes were observed in the present investigation on *Pestalotiopsis* species. In *P. maculans* the cells lining the pycnidial cavity commence conidial formation. Although initially indistinguishable from the cells lining the cavity, the conidiogenous cells differed in remaining thin walled and hyaline whereas, the wall cells become pigmented and thick - walled (Figs. 15 -17). The processes of conidiation and dislodgement of conidiogenous cells continued till the cavity is filled up (Fig. 16) The temporary conidiogenous cells resemble more or less the pycnidial wall cells in size and shape (Fig.18). Subsequently, these temporary conidiogenous cells were replaced by the formation of permanent conidiogenous cells which were easily distinguished by their size and shape from the temporary conidiogenous cells. The permanent conidiogenous cells are cylindrical and annellidic with one or two annellations. The later formed conidiogenous cells are typically cylindrical in shape showing 1-3 annellations. The conidioma becomes flattened in shape during the later stages of development. The mature conidioma produces conidiogenous cells which line only the flattened basal region but not the sides and upper region of the conidioma.

Dehiscence of conidioma to release the conidia

There is no regularly formed ostiole found in this species. After maturity the upper layers of the conidioma open quite irregularly to release the conidia.

Electron Microscopical Studies

Electron microscopy of conidiogenous cell

The primary conidium arises as a protrusion of the apex of the conidiogenous cell and develops holoblastically. Cell organelles migrate into the developing conidium until a delimiting septum is formed more or less near the base of the conidium initial. As the conidium enlarges, the conidium wall forms an electron-opaque outer layer which starts from the base of the conidium. The inner transparent layer appears continuous with the wall of the conidiogenous cell. The conidiogenous cell itself does not develop an electron-opaque outer wall. Successive conidium develops from a point just at or below the level at which the preceding conidium was delimited. At least 3-4 annellations were observed in each conidiogenous cell (Fig.19). Sections through the young conidiomata showed that the conidia arise from spherical to subspherical conidiogenous cells lining their cavity (Fig.18). Prior to septation, the conidium initial is enclosed by a thin electron transparent wall. During septation the wall increases in thickness. Usually the first septum is laid near the tip of the initial. Gradually the peripheral region of the conidial wall becomes electron dense by the deposition of the melanin in the wall matrix.

The conidia consist of three thick-walled median cells capped by hyaline end cells (Fig. 20). In the distilled water mounts of the conidia the wall of the three median cells appears granular and pale brown. During germination the germ tubes arise exclusively from the lowermost median cells. The hyaline basal cell bears an unbranched appendage. Appendages (4-5) also arise from the hyaline apical cell.

Median coloured cells

Transconidial septa arise as outgrowths of the conidial wall and new wall material is deposited external to the invaginations. During the growth of membrane across the conidium, wall material is continuously produced through the cell wall developed by each membrane. The septal pore formed as a result of cessation of wall deposition at the junction where the plasma membranes from either side fuse to form the trans-septal membrane. Simultaneously in the septal formation, wall deposition occurs over the entire inner surface of the conidium. The peripheral walls and the septa of the conidia become distinctly electron dense (Fig. 20). The thickness is more in the upper two median cells when compared to lower median cell. The lower median cell is structurally different from the other median cells of the conidium in that it showed pronounced wrinkling of the outer pigmented wall. Probably because of this difference in the nature of the wall it appears pale brown in colour under the light microscope.

Apical and basal cells

The apical and basal cells are morphologically indistinguishable from the median cells during the early stages of development of the conidium. At maturity the end cells showed cytolysis and the cytoplasmic content completely disappears from these cells. The thicknesses of the electron-dense layer of the apical and basal cells gradually decrease.

Basal appendage

The conidia were produced from the annellides and more than 3 annellations were observed in some conidiogenous cells (Fig.19). Occasionally the basal appendage of the developing conidium was observed within the annellation which shows that the basal appendage is endogenously produced.

Apical appendage

Apical appendage originated from the apex of the conidium as a simple elongation of a small bud produced at an early stage of the development of the conidium.

Discussion

Species of *Pestalotiopsis* have not been studied with reference to the development of conidiomata. The present study reports for the first time the various stages of development of conidiomata in *Pestalotiopsis maculans* with interesting observations. The developmental morphology of the conidiomata in the species has shown interesting features. The fungus produces conidia only inside mature conidiomata. As the primordium increases in size, the central cavity is to be formed because the primordium is a compactly packed pseudoparenchymatous tissue. In *P. maculans* the central cells in the primordium shows signs of schizogenous and lysigenous activity to form the central cavity. The remaining portions of the cells often gelatinize and fill up cavity with the mucilagenous matrix. Probably, the matrix provides nutrition to the developing conidiogenous cells and conidia. Nag Raj (1981) suggested that the slime, which originates though lysis occurring during cavity

formation, play a important role in conidium dispersal. The presence of mucilagenous matrix during the formation of the pycnidial conidiomata was reported in certain other pycnidial Coelomycetes also (Masilamani & Muthumary 1994, 1995 &1996). The formation of conidiogenous cells inside the cavity of the conidioma is another interesting feature studied in this species. The pioneering work of Punithalingam (1979) who studied in detail the process of conidiation in *Ascochyta* species in culture, revealed a similar process on this fungus.

The production of temporary and permanent conidiogenous cells in *Ascochyta* is construed as a general feature of *Ascochyta* species in culture (Punithalingam, 1979). Similarly, the dual conidiation process was also observed in species of *Pestalotiopsis* in the present investigation. The dual conidiation process was observed in *Phyllosticta caryota* in culture. Punithalingam (1979) reported that some of the observations made with *Ascochyta* in culture were in conformity with the interpretations of Archer (1926) during his investigation on cavity formation and ostiole development in some members of Sphaeropsidales. This suggests that probably these fungi which produce pycnidial conidiomata in culture follow some specific regularity in their conidiomatal development. It is not possible to conclude that these stages of developmental processes occur during the formation of the pycnidia in nature.

Fine structure of the conidia were demonstrated in four Coelomycete species (Campell 1968), Sutton and Sandhu,1969; Griffiths and Swart,1974 a,b).Generally, these studies were intended to extend light microscopic observations. Longitudinal sections through the conidia of *Pestalotiopsis maculans* showed massive and pigmented conidial wall. The conidial wall is characterized by the deposition of electron dense material in the outer layers of the septa. The transconidial septa arise as outgrowths of the conidial wall and new wall material is deposited external to the invagination of the plasmamembrane. The basal and apical cells have partly pigmented and partly unpigmented wall, which are clearly distinct from the central cell. During germination the germ tubes arise exclusively from the lowermost median cells. The hyaline basal cell bears an unbranched appendage. Apical appendages also arise from the hyaline apical cell. The conidia are produce from annellides and upto three annellations were observed. The basal appendage of the developing conidium was sometimes observed within the annellide. The basal cell along with the appendage remained viable long after the cytolysis of the apical cell.

Sutton (1961) Observed that versicoloured conidia in *Pestalotiopsis* species produced germ tubes only from the inferior coloured cell. His observations are confirmed in the present investigation that the germ tube is produced only from the lower most median colored cell. The upper two coloured cells do not possess any germ pore in their cells, which might have prevented them from germinating. Electron microscopical studies showed that the lowermost median cell is morphologically as well as structurally different from the other two cells in that it is slightly larger than the other cells. In thickness also it differs from the other two cells. In some of the sections, this cell showed more shrinkage when compared with the other two cells. Also during germination, there is a breakage in both the layers of the wall so that the cytoplasm emerges out to form the germ tube. Therefore, as evidenced by electron microscopic studies, the lower most median cell is morphologically and structurally different from the other two cells. As suggested by Sutton (1961) the upper two cells provide

mechanical support by being thicker than the lower most cell to facilitate the emergence of the germ tube.

According to Steyaert (1949, 1953 a,b, 1954, 1955, 1961) *Pestalotiopsis* has 4-septate conidia, a view accepted by Sutton (1969a, 1980). Nag Raj (1985a, 1986c, 1989a) however, included 3-septate forms as well in the genus. The studies by Guba (1961), Steyaert (1949) and others on this genus have been based mainly on dried herbarium material. As suggested by Sutton (1980), when these fungi are grown in artificial culture media, they showed different characters especially with reference to fructification and conidium ontogeny. The developmental morphology of conidioma in *Pestalotiopsis* resembles that of *Ascochyta* which is a well-known pycnidial fungus. This suggests that the distinction between Hyphomycetes and Coelomycetes may have to be abandoned, as more data becomes available.

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MORPHOLOGICAL CLADISTIC ANALYSIS OF TROPICAL HYMENOGYNETALES (BASIDIOMYCOTA)

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ABSTRACT

A cladistic analysis of some tropical Hymenochaetales, based in basidiome morphology, was carried out. The ingroup encompasses 11 tropical hymenochaetalean species, including those of the most diverse genus (*Phellinus*) and also of three other genera: *Aurificaria*, *Hymenochaete* and *Phylloporia*. Three outgroups were selected: *Trichaptum byssogenum*, *Datronia caperata* and *Auricularia polytricha*. Cladistic analysis using parsimony was performed with NONA 2.0, implemented by WINCLADA 0.9.99. Cladograms were produced using heuristics search with random taxon addition sequences, tree-bisection-reconnection branch swapping. A total of 17 characters were used in the cladistic analysis and treated as non-additive. One most parsimonious cladogram was produced with 30 steps in length, CI = 0.70 and RI = 0.78. Ten putative monophyletic groups were identified. Ingroup monophyly and polyphyly of the genus *Phellinus* were supported. Basidiospore wall thickness and basidiospore color exhibited high phylogenetic signal.

KEY WORDS: Basidiome morphology, phylogeny, Hymenochaetales

INTRODUCTION

The order Hymenochaetales Oberwinkler (Fungi-Basidiomycota-Homobasidiomycetes), according to Pegler & Young (1993), is characterized by the presence of setoid structures, euhymenial development, permanent positive xanthochroic reaction and generative hyphae without clamp-connections, comprising two families: Asterostromataceae (Donk) Pouzar and Hymenochaetales Donk.

The family Hymenochaetales is constituted of 12 genera exhibiting distinct hymenophore configurations: *Aurificaria*, *Clavariachaete*, *Coltricia*, *Coltriciella*, *Cyclomyces*, *Hydnochaete*, *Hymenochaete*, *Inonotus*, *Phellinus*, *Phylloporia*, *Pyrrhoderma* and *Stiptochaete*. Only two genera are assigned to Asterostromataceae: *Asterostroma* and *Asterodon*. Except for *Coltricia*

perennis, which is facultatively ectomycorrhizal, all species are white-rot wood-decay fungi, saprobes or facultative parasites of trees and most of taxa are of tropical distribution (Hawksworth et al., 1995; Ryvarden 1991, 1993).

Many authors (Parmasto, 1970; Oberwinkler, 1977; Hallenberg, 1985), however, considered *Asterostroma* as a member of Lachnocladiaceae (Reid, 1965) but assigned *Asterodon* to Hymenochaetaceae. Thus the taxonomic position of *Asterostroma* is debatable.

Although *Asterostromataceae* (*sensu* Pegler and Young) exhibit at least one distinctive morphological feature (presence of asterosetae), Hymenochaetaceae is generally negatively defined as comprising all Hymenochaetales without asterosetae. Furthermore the circumscription of hymenochaetacean genera is rather imprecise even in the realms of traditional systematics (Corner, 1991). The same situation occurs at the generic level, notably in *Phellinus*, which accounts for more than half of total number of species of Hymenochaetales. That genus includes several species complexes and it is generally regarded as polyphyletic (Ryvarden, 1991; Fischer, 1996). Thus the great taxonomic challenge is to delimit potentially monophyletic groups inside *Phellinus* and in Hymenochaetaceae as a whole.

Phylogenetic studies concerning Hymenochaetales include those of Fiasson & Niemelä (1984) and Bondarceva et al. (1992). The former work comprised a phenetic and cladistic analysis of European poroid taxa based in morphology, biochemical and protein-based molecular methods. In order to determine the polarity of characters, Fiasson & Niemela (1984) used a likely ingroup terminal (*Hymenochaete*) as outgroup and, for some characters, the incorrect criteria of commonness in outgroup analysis (Forey et al., 1992). Bondarceva et al. (1992) carried out a strictly phenetic analysis based in morphological and chemical characters of Cuban polyporoid Hymenochaetales.

This work intends to carry out a cladistic analysis of some tropical hymenochaetalean fungi based mainly in basidiome morphology and some ecological characters as well as to test ingroup monophyly and to evaluate postulated evolutionary hypotheses of ingroup relationships (Fiasson & Niemelä, 1984; Corner, 1991; Ryvarden, 1991).

MATERIALS AND METHODS

Terminal taxa and choice of outgroup

Both outgroup and ingroup taxa were collected during field trips in the State of Bahia, Brazil, and studied specimens were deposited in HUEFS herbarium. Macroscopic features were analyzed in a stereomicroscope and freehand sections were made for the study of microscopic characteristics. Slide preparations were stained with 1% phloxine, 5% KOH, and Melzer's reagent was used to test iodine reaction as in Common (1991).

The ingroup encompasses 11 tropical hymenochaetacean species. Eight taxa are species of *Phellinus*; the other three taxa are species of three other genera: *Aurificaria*, *Hymenochaete* and *Phylloporia*.

Three outgroups were selected: (a) *Trichaptum byssogenum*, since the genus *Trichaptum* is likely to be the sister group of Hymenochaetales according to molecular studies of 18S r-DNA gene (Ko, Hong & Jung, 1997) and

morphological hypothesis (Corner, 1987); (b) *Datronia caperata* was selected as a possible functional outgroup for *T. byssogenum* because it corresponds to a level of higher generality, representing the Homobasidiomycetes as a whole; and (c) *Auricularia polytricha*, which is a Heterobasidiomycete, as a functional outgroup of the other two taxa, comprising the highest level of generality, for Auriculariales is presumed to be the sister group of Homobasidiomycetes (Lipscomb et al., 1998). Thus outgroups were selected in order to represent different levels of hierarchically nested groups. All the terminals used in this study and their geographical distribution patterns are listed in Table I.

Table I: Terminal taxa studied.

Taxon	Voucher specimen (HUEFS)	Geographical distribution pattern
<i>Auricularia polytricha</i> (Mont.) Sacc.	(41463), (41497), (41500)	Pantropical
<i>Datronia caperata</i> (Berk.) Ryv.	(41461), (41462)	Pantropical
<i>Trichaptum byssogenum</i> (Jungh.) Ryv.	(41457), (41490)	Pantropical
<i>Aurificaria luteo-umbrina</i> (Rom.) Reid	(41401), (41417), (41459)	Pantropical
<i>Hymenochaete sallei</i> Berk. & Curt.	(41470), (42788)	Pantropical
<i>Phellinus apihaynus</i> (Speg.) Rajch. & Wright	(41790)	Neotropical
<i>Phellinus extensus</i> (Lév.) Pat.	(41425), (41426), (41427), (41469)	Neotropical
<i>Phellinus gilvus</i> (Schw.) Pat.	(41428), (41429), (41465)	Pantropical
<i>Phellinus grenadensis</i> (Murr.) Ryv.	(41422), (41423), (41424), (42789), (42786)	Neotropical
<i>Phellinus melleoporus</i> (Murr.) Ryv.	(41451), (41471)	Neotropical
<i>Phellinus membranaceus</i> Wright & Blumenf.	(41452), (41499)	Neotropical
<i>Phellinus palmicola</i> (Berk. & Curt.) Ryv.	(41454), (42783)	Neotropical
<i>Phellinus rimosus</i> (Berk.) Pil.	(41419), (41420), (41421), (41468)	Pantropical
<i>Phylloporia pectinata</i> (Kl.) Ryv.	(41455), (42787)	Pantropical

Phylogenetic Analysis

Cladistic analysis using parsimony was performed with NONA Version 2.0 (Goloboff, 1993), implemented by WINCLADA Version 0.9.99 (Nixon, 1999). Cladograms were produced using heuristics search with random taxon addition sequences, tree-bisection-reconnection branch swapping. WINCLADA was also used to examine character distribution.

RESULTS

A total of 17 characters were used in the cladistic analysis (Table II). Thirteen characters were binary and four were multistate. All characters are treated as non-additive since there is no discernable basis for coding any transformation series *a priori* (Hauser & Presch, 1991). Five characters are parsimony uninformative, for they constitute autapomorphies. The character states distributions for taxa included in the analysis are shown in Table III. Consistency (CI) and retention (RI) indexes for each character are listed in Table IV.

Phylogenetic analysis conducted in NONA resulted in 1 most parsimonious cladogram of 30 steps in length with CI = 0.70, RI = 0.78 and RC = 0.55 (fig.1). Ten clades were identified (designated as groups 1-10).

Table II: Character and Character states used in the analysis

Character Number	Character	Character State
0	Basidiome type	(0) Pileate (1) Resupinate
1	Basidiome longevity	(0) Seasonal (1) Perennial
2	Hymenial configuration type	(0) Smooth (1) Poroid
3	Context color	(0) Whitish (1) Brown (2) Yellowish to reddish brown
4	Hyphal system	(0) Monomitic (1) Eudimitic (2) Intermediate Dimitic
5	Hymenial setae	(0) Absent (1) Present
6	Crystal hyphae	(0) Absent (1) Present
7	Basidiospore shape	(0) Cylindric (1) Ellipsoid (2) Globose
8	Basidiospore wall thickness	(0) Thin (1) Thickened
9	Basidiospore color	(0) Hyaline (1) Colored
10	Nutritional Strategy	(0) Saprobe (1) Parasite
11	Spore color change in KOH	(0) Unchanged (1) Olivaceous
12	Clamp-connections	(0) Present (1) Absent
13	Permanent KOH reaction	(0) Negative (1) Positive
14	Encrusted hymenial cystidia (metuloids)	(0) Absent (1) Present
15	Basidium shape	(0) Cylindric (1) Clavate (2) Subglobose
16	IKI reaction of spores	(0) Negative (1) Positive (dextrinoid)

Table III: Character state matrix (outgroups marked with an asterisk)

Table III: Character-state matrix (outgroups marked with an asterisk)																	
	Characters																
Taxa	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<i>Auricularia polytricha</i> *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Trichaptum byssogenum</i> *	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0
<i>Datronia caperata</i> *	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0
<i>Hymenochaete sallei</i>	1	0	0	2	0	1	0	0	0	0	0	0	1	1	0	0	0
<i>Aurificaria luteo-umbrina</i>	0	0	1	2	2	0	0	2	1	1	0	1	1	1	0	2	0
<i>Phylloporia pectinata</i>	0	1	1	2	2	0	0	1	1	1	0	0	1	1	0	2	0
<i>Phellinus rimosus</i>	0	1	1	2	1	0	0	2	1	1	1	0	1	1	0	2	0
<i>Phellinus gilvus</i>	0	0	1	2	1	1	1	1	0	0	0	0	1	1	0	1	0
<i>Phellinus palmicola</i>	1	0	1	2	1	1	0	0	0	0	0	0	1	1	0	0	0
<i>Phellinus apiahynus</i>	0	1	1	2	1	0	0	2	1	0	0	0	1	1	0	1	1
<i>Phellinus extensus</i>	0	1	1	2	1	1	0	2	1	1	0	0	1	1	0	2	0
<i>Phellinus grenadensis</i>	0	1	1	2	1	0	0	1	1	1	0	0	1	1	0	1	0
<i>Phellinus membranaceus</i>	1	0	1	2	1	0	0	1	1	1	0	0	1	1	0	1	0
<i>Phellinus melleoporus</i>	1	1	1	2	1	0	0	1	1	1	0	0	1	1	0	1	0

Table IV: CI and RI of each character in most parsimonious cladogram (uninformative characters are in *italic*)

Character Number	Character	Number of steps	CI	RI
0	Basidiome type	2	0.50	0.66
1	Basidiome longevity	3	0.33	0.60
2	Hymenial configuration type	2	0.50	0
3	Context color	2	1	1
4	Hyphal system	3	0.66	0.50
5	Hymenial Setae	2	0.50	0.66
6	<i>Crystal hyphae</i>	1	1	1
7	Basidiospore shape	4	0.50	0.71
8	Basidiospore wall thickness	1	1	1
9	Basidiospore color	1	1	1
10	<i>Nutritional Strategy</i>	1	1	1
11	<i>Spore color change in KOH</i>	1	1	1
12	Clamp-connections	1	1	1
13	Permanent KOH reaction	1	1	1
14	<i>Incrusted hymenial cystidia (metuloids)</i>	1	1	1
15	Basidium shape	3	0.66	0.83
16	<i>IKI reaction of spores</i>	1	1	1

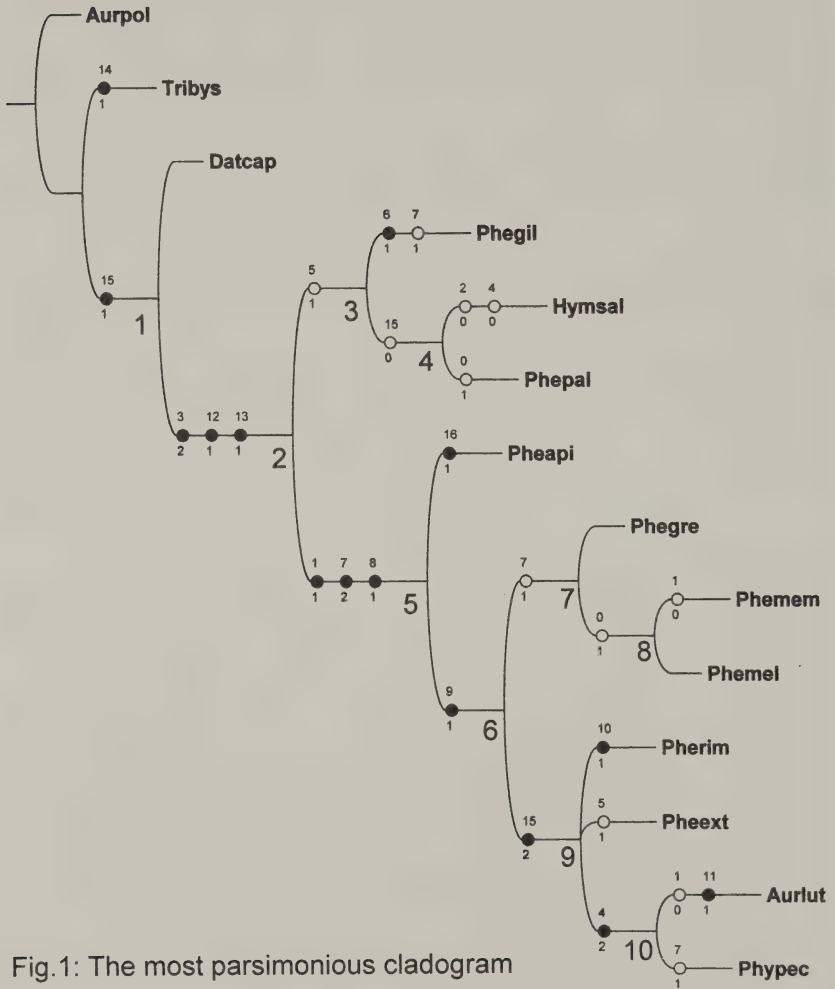


Fig.1: The most parsimonious cladogram

(synapomorphies/autapomorphies = full circles)
(homoplasies = empty circles)
(upper numbers = characters)
(lower numbers = character states)
(big numbers = clades)

DISCUSSION

Clades

Clade 1 includes the ingroup and one of the outgroups. It is supported by one synapomorphy, 15(1), suggesting that, at least in the light of morphological characters, *Datronia caparata* is more closely related to Hymenochaetaceae than *Trichaptum byssogenum*. Studying the molecular phylogenetic relationships of *Trichaptum*, Ko, Hong & Jung (1997) showed that *Trichaptum* species were closer to *Inonotus* (Hymenochaetaceae) than to the 31 different species of Aphyllophorales. Unfortunately none of the studied species was of the genus *Datronia* and there was no *Inonotus* species in our own analysis. *Trichaptum* and Hymenochaetaceae species (with the exception of *Coltricia perennis*) present imperforate parenthosomes, a rare condition in Holobasidiomycetes (Moore, 1985). At this time there is no data in literature about septal ultrastructure in *Datronia caperata* but, if the clade 1 is, in fact, natural, this taxon may possess imperforate parenthosomes.

Clade 2 includes all the ingroup and is supported by three synapomorphies: 3(2), 12(1), and 13(1). It is one of two most supported clades in terms of synapomorphies and represents all terminal taxa only pertaining to Hymenochaetales. All studied hymenochaetalean taxa exhibit permanent xanthocroic reaction, clampless hyphae and yellowish to reddish brown context. Thus it is assumed that the ingroup is monophyletic, as it has been long advocated (Donk, 1948; Oberwinkler, 1977).

Clade 3 is supported by one convergence 5(1) and comprises a group formed by the taxa *Phellinus gilvus*, *Phellinus palmicola* and *Hymenochaete sallei*. This clade suggests the polyphyly of *Phellinus* (Fiasson & Niemelä 1984; Ryvarden, 1991; Hibbett & Donoghue 1995; Fisher, 1996). Nevertheless it is not in accordance with the proposed suborder Hymenochaetinae Fiasson & Niemelä (Fiasson & Niemelä, 1984) or Hymenochaetaceae *sensu* Boidin (Boidin, Mugnier & Canales 1998) since it grouped *Hymenochaete* and *Phellinus* species together. All three taxa in this clade possess hymenial setae, and hyaline, thin-walled spores. These characters are also found in *Hymenochaete*, *Stiptochaete* and *Hydnochaete* (Job, 1990; Ryvarden, 1982, 1985), which suggests that they are closer related to each other than to other Hymenochaetaceae. According to Fisher (1996), *Phellinus torulosus*, a temperate species closely related to *Phellinus gilvus*, is more closely linked to *Phellinus ferreus* group (*Fuscoporia* Murr.).

Clade 4 is supported by one reversal 15(0), and includes *Phellinus palmicola* and *Hymenochaete sallei*. These two taxa are unique among the ingroup taxa in their possession of long subulate hymenial setae. *Phellinus palmicola* falls into the definition of *Fuscoporia* Murr. emend. Fiasson et Niemelä (Bondacerva et al., 1992), which comprises *Phellinus* species with extremely thin-walled, acyanophilous spores, mostly cylindric in shape, features that also occur in *Hymenochaete* and *Hydnochaete* species (Job, 1990; Ryvarden, 1982). This suggests a close relationship between *Fuscoporia*, *Hymenochaete* and *Hydnochaete*. All studied *Fuscoporia* species are binucleate, homothallic and putative haploid (Fisher, 1996). Therefore these character states are also expected to occur in representatives of this clade.

Clade 5 is supported by three synapomorphies 1(1), 7(2) and 8(1). It includes all the ingroup taxa with the exclusion of *Phellinus gilvus*, *Phellinus palmicola* and *Hymenochaete sallei*. All the taxa in this group exhibit spores with thickened walls, which is in sharp contrast with the aforementioned Hymenochaetaceae bearing thin-walled spores. The subglobose, dextrinoid spores, and the presence of ampullaceous cystidioles in the hymenium indicate that *Phellinus apiahynus* probably belongs to *Phellinus robustus* group (*Fomitiporia* Murr.), as defined by Fiasson & Niemelä (1984). Thus, with regard to karyology, sexuality and DNA content of nuclei, it is expected that this taxon is oligonucleate, homothallic and putative diploid (Fischer, 1996).

Clade 6 is supported by one synapomorphy 9(1) and comprises all the species of clade 5 but *Phellinus apiahynus*. All the hymenochaetacean taxa with colored and thick-walled spores grouped in this clade, which also includes, besides *Phellinus*, species of the genera *Aurificaria* and *Phylloporia*, reinforcing the supposed polyphyletism of the genus *Phellinus*.

Clade 7 is supported by one reversal 7(1) and encompasses three eudimitic Neotropical *Phellinus* with colored, thick-walled, ellipsoid spores and without hymenial setae.

Clade 8 is supported by one convergence 0(1) and consists of resupinate species of the clade 7.

Clade 9 is supported by one synapomorphy 15 (2) and comprises pantropical *Phellinus*, *Aurificaria* and *Phylloporia* species with subglobose basidia. Except for *Phellinus extensus*, which has hymenial setae, all representatives of clade 7 can be considered as part of the so called *Phellinus rimosus* complex (Kotlaba & Pouzar, 1978), corresponding to *Fulvifomes* Murr. This complex comprises species with colored, thick-walled spores and without setae such as *Aurificaria* and *Phylloporia* terminals included in our study.

Clade 10 is supported by one synapomorphy 4(2). It groups together all the intermediate dimitic species of the ingroup. The term "intermediate dimitic" was proposed by Pegler (1995) in order to group all the types of hyphal system that are clearly distinct from the typical Basidiomycota monomitic system but do not fit well in the definition of the eudimitic hyphal system. Intermediate dimitic system corresponds to "type d1" and "type d2" of Corner's classification (Corner, 1991).

Parsimony informative Characters

Basidiome Type

The basidiomes of Hymenochaetales, in special, and Basidiomycota, as a whole, generally fall into three broad categories: (a) resupinate, (b) pileate, and (c) stipitate. There are, of course, transitions between these categories and it is quite impossible to make sharp distinctions among all of them (Ryvarden, 1991). Furthermore depending on the position of the basidiome on the substrate (on horizontal or vertical surfaces), one species could, for example, develop basidiomes of distinct types even along the same trunk. Both stipitate and pileate or pileate and resupinate basidiomes could occur in the same species, and it is frequently recommended to check the basidiomes of each species under different conditions (Corner, 1991). This

character was moderately homoplastic with a CI of 0.50. The interpretation of the cladogram suggests that resupinate basidiome is an apomorphic condition in Hymenochaetales and it may have arisen at least twice since it occurs in two different lineages. This hypothesis is in accordance with Corner's (1991) and Fiasson & Niemelä's (1984) ideas.

Basidiome longevity

It is not always practical to distinguish between seasonal (annual) and perennial basidiomes, especially if the studied basidiome corresponds to the first season's growth of a perennial species (Corner, 1991). Basidiome longevity was the most homoplastic character (CI=0.33). According to our analysis, perenniality is the apomorphic condition in the ingroup. Corner (1991) and Fiasson & Niemelä (1984) also shared this hypothesis. Reversals to seasonality occurred at least twice during the evolution of Hymenochaetales

Hymenial configuration type

As well as basidiome shape, hymenial configuration forms the basis of the final version of the Friesian system. Owing to limited taxon sampling, little (if anything) could be said about the evolution of this character since we did not include Hymenochaetales with hydroid (*Hydnochaete*) and concentric lamellate (*Cyclomyces*) hymenophores in our analysis. A reversal to the smooth condition (present in the Heterobasidiomycete outgroup representative) occurs in only one lineage among studied taxa.

Context color

One of the most distinctive features of Hymenochaetaceae is the color of the basidiome (upper surface, context, trama and hymenial surface). The context is distinctly yellowish (to reddish) brown. This color is due to the presence of hyphae with yellowish brown walls (Pinto-Lopes, 1952; Snell & Dick, 1957;). All known species of Hymenochaetales exhibit a yellowish (to reddish) brown context. This character appears as one of the synapomorphies of the ingroup.

Hyphal system

The circumscription of the three basic categories of hyphal system (monomitic and dimitic, no typical trimitic hyphal system occurs in Hymenochaetales) followed Corner (1991). A strictly monomitic system, with no difference in the direction, form and branching of the hyphae was only found in the Heterobasidiomycete outgroup representative (*Auricularia polytricha*) and in the ingroup representative, *Hymenochaete sallei*, indicating a reversal to that condition.

There is considerable variation among dimitic systems in Hymenochaetales (Corner, 1991). We were able to distinguish two broad categories from the studied terminals: (a) a system comprising typical generative hyphae and sparingly branched, septate, slightly thick to thick-walled

skeletal hyphae, which corresponds to types d1 and d2 in Corner's classification (1991), and to the intermediate dimitic type in Pegler's review (1995); (b) a system comprising the typical unbranched skeletal hyphae corresponding to type d3 of Corner (1991), which is called "eudimitic" in this work. According to our analysis, the intermediate dimitic system is the apomorphic condition in Hymenochaetales.

Hymenial setae

Based in the presence of hymenial setae, Patouillard (1900) erected his *Série des Ignaires*, which comprised genera with varied basidiome shapes and hymenial configurations, united by the presence of setae. This group represented the core of the family of Hymenochaetaceae (Donk, 1948). The presence of hymenial setae is a synapomorphy of Hymenochaetales. The absence of hymenial setae in hymenochaetalean taxa is clearly a reversal, for the exclusive common ancestor of the group must possess hymenial setae.

Basidiospore shape

As well as in the other characters, there are transitions between the three broad categories of basidiospore shape and the following circumscriptions were adopted: (a) globose = globose to subglobose spores, (b) ellipsoid = oblong to broadly ellipsoid, (c) cylindric = subcylindric to cylindric (Ryvarden, 1991). Ellipsoid and globose basidiospores are the apomorphic conditions in Hymenochaetales. Although only one step is enough to explain the origin of globose basidiospores, the ellipsoidal shape of basidiospores might have arisen at least three times in the group.

Basidiospore wall thickness

Basidiospores with thickened walls, which is the apomorphic condition, might have appeared only once in the evolution of Hymenochaetales. This hypothesis is in accordance with Fiasson & Niemelä (1984) but not with Corner (1991), who believed this condition was plesiomorphic.

Basidiospore color

As well as basidiospore wall thickness, no homoplastic event is necessary to be evoked to explain the evolution of basidiospore color. Colored basidiospore is the apomorphic condition in Hymenochaetales. Again, our hypothesis is shared by Fiasson & Niemelä (1984) and it is the opposite of what Corner (1991) supported.

Clamp-connections

All known hymenochaetalean taxa are clampless (Kühner, 1950, Oberwinkler, 1977, Corner, 1991, Ryvarden, 1991). Although there has been demonstrated several times that many aphylloroid species, which bear clampless generative hyphae in their basidiomes, were capable of producing

clamped hyphae in culture (Stalpers, 1978), there is only one (and probably doubtful) report of clamped hyphae in cultures of two species of Hymenochaetales (Nobles, 1965). The absence of clamp-connection is thus a synapomorphy of the group.

Permanent KOH reaction

As well as in the case of the absence of clamp-connections, all known Hymenochaetales show a positive and, most important, permanent xanthocroic reaction, that is, when the basidiome permanently and noticeably darkens in an alkaline solution, usually KOH (Pegler, 1973). The permanent xanthocroic reaction is due to the presence of a typical group of secondary metabolites, styrylpyrones, which are found, among Basidiomycota, in Hymenochaetales (Fiasson, 1982). Basidiomes of one of the outgroup taxa, *Datronia caperata*, also darken in the presence of KOH as many other basidiomes of aphyllophoroid taxa do (Parmasto & Parmasto, 1979) but the darkening reaction is not permanent. The permanent KOH reaction is one of the synapomorphies of Hymenochaetales.

Basidium shape

Subglobose basidium is the apomorphic condition in Hymenochaetales. The cylindric basidia found in terminals of the clade 4 (*Hymenochaete sallei* and *Phellinus palmicola*) could be regarded as a reversal because the exclusive common ancestor of Hymenochaetales probably possessed clavate basidia according to our analysis.

CONCLUSIONS

The monophyly of the ingroup (Hymenochaetales) and the polyphyletism of *Phellinus* are supported in our morphological cladistic analysis. The non-poroid Hymenochaetales representative grouped together with poroid representatives, indicating that a reevaluation of proposed classification schemes in this order, which group non-poroid species separately (Fiasson & Niemelä, 1984; Boidin, Mugnier & Canales, 1998), is needed.

Our results also suggest that the evolution of Hymenochaetales has been marked by homoplasy events, not only in macromorphological characters, as expected, but also in micromorphological ones. On the other hand some micromorphological characters, such as basidiospore wall thickness and basidiospore color, exhibited high phylogenetic signal, clearly indicating some of the ingroup relationships.

These features, combined with a more complete sampling of the Hymenochaetales including all major lineages such as hydroid, cyclomyroid and asterosetal representatives, may provide better clues to understand pathways of morphological evolution in this group of Homobasidiomycetes.

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THE GENUS *KRETZSCHMARIA* FROM TUCUMAN, ARGENTINA

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ABSTRACT Six taxa of *Kretzschmaria* -including those taxa formerly considered as *Ustulina*- from Argentina are described and included in keys. Two new species, *Kretzschmaria argentinensis* and *K. sigmoidirima*, are proposed. *K. deusta*, *K. sandvicensis* and *K. pavimentosa* are first records from Argentina. The distribution area in Argentina of *K. clavus* is enlarged.

Keywords: Xylariaceae, new species, *Kretzschmaria argentinensis*, *K. sigmoidirima*, *Ustulina*.

INTRODUCTION

During a survey of species belonging to the family Xylariaceae in Tucumán Province in NW Argentina, species of the genus *Kretzschmaria* were studied. *K. clavus* (Fr.: Fr.) Sacc. is the only record from Argentina made by Spegazzini (1909). Neither in other papers by Spegazzini (1880, 1881) on the group nor in the works of Dennis (1956, 1957, 1958) on South American material have any species of this genus been recorded from Argentina.

The purpose of this paper is to present the results of the study of 74 specimens collected during several years. These results include the proposal of two new species, the report of three first records for Argentina, and a key to these six Argentine *Kretzschmaria* species.

MATERIALS AND METHODS

During 1999 four samplings were carried out, one per season in summer, autumn, winter and spring, in the montane forest of Tucumán, specifically in "The Yungas Phytogeographic Province" or "Tucumano-Bolivian Forest" (Cabrera, 1971, Hueck 1978). In total 74 samples were collected. The materials were air-dried and brought into culture. Teleomorphic specimens were preserved in LIL and BAFC. Previous collections (1988/89/95/97/98), kept at LIL and 54 specimens from BAFC, BPI, FH,

GZU, ITCV, K, LIL, LPS, NY, S, W, WSP were also studied (herbarium abbreviations follow Holmgren *et al.*, 1990).

Observations and measurements were taken from fresh material squash-mounted in distilled water, 5% KOH and phloxine for optical microscopy and in Melzer's reagent for the amyloid reaction (IK). Drawings were made with a camera lucida.

Cultures were made from teleomorphic stromata as follows. The upper part of a perithecium-bearing stroma was removed with a sterile razor blade. The contents of the exposed perithecium were rehydrated with sterile distilled water, scooped out with a sterile needle and transferred to a Petri plate containing 2% Oatmeal agar in 9 cm diam. Petri plates and incubated under laboratory conditions at approximately 12 hr per day fluorescent light at 20 ° C.

RESULTS

From the 74 collections, 39 specimens were identified as *K. clavus* (Fr: Fr) Sacc., 18 as *K. deusta* (Hoffm.: Fr.) P. Martin, 3 as *K. pavimentosa* (Ces.) P. Martin, 5 as *K. sandvicensis* (Reichardt) J. D. Rogers & Y.-M. Ju, 6 as the new species, *K. argentinensis* A.I.Hladki & A.I.Romero, and 2 as another new species *K. sigmoidirima* A.I.Hladki & A.I.Romero.

Key to species of *Kretzschmaria* from Argentina

1. Stromata stipitate or sessile, the fertile parts and/or stipes often fused; individual parts seldom exceeding 1 cm diam.....2
1. Stromata more or less sessile, but often attached by rhizoid-like processes or narrow connectives; fertile parts usually exceeding 1 cm diam.....4
2. Ascospores with a conspicuously sigmoid to spiral germ slit.....*K. sigmoidirima* sp. nov.
2. Ascospores with a straight germ slit shorter than spore length.....3
3. Ascospores 35-40.5 x 10.5-12 µm, stromata usually stipitate, the fertile part 1-3 mm diam, strongly roughened by scales.....*K. argentinensis* sp. nov.
3. Ascospores 25-30 x 6.5-9 µm, stromata stipitate, the fertile part 2-5.5 mm diam, smooth.....*K. clavus*
4. Ascospores mostly longer than 40 µm.....*K. pavimentosa*
4. Ascospores mostly shorter than 40 µm.....5
5. Ascospores 26-31.3 x 6.5-7.8 µm, with a germ slit shorter than spore length.....*K. deusta*
5. Ascospores 32.5-40.3 x 9.1-12 µm, with a germ slit slightly shorter than spore length.....*K. sandvicensis*

DESCRIPTIONS

Kretzschmaria argentinensis A.I. Hladki & A.I. Romero, sp. nov.

(Fig. I: 1-5; Fig. III: 3)

Etym.: after Argentina

A *Kretzschmaria clavus* differt in ascosporis (35.1-40.3 x 10.4-11.7 µm) dimensionis, et in stromatibus per parvos clavos cum superficiebus rimosis compositis. Holotypus **LIL**: Argentina: Tucumán: Depto. Chicligasta, Parque Provincial El Cochuna, ad viam prov. 331, Camping Samay, 1300 m asl., in ligno indet., 17-XI-1999, Hladki 2303. Isotypus **BAFC** 50.692 et **BPI** 747.563.

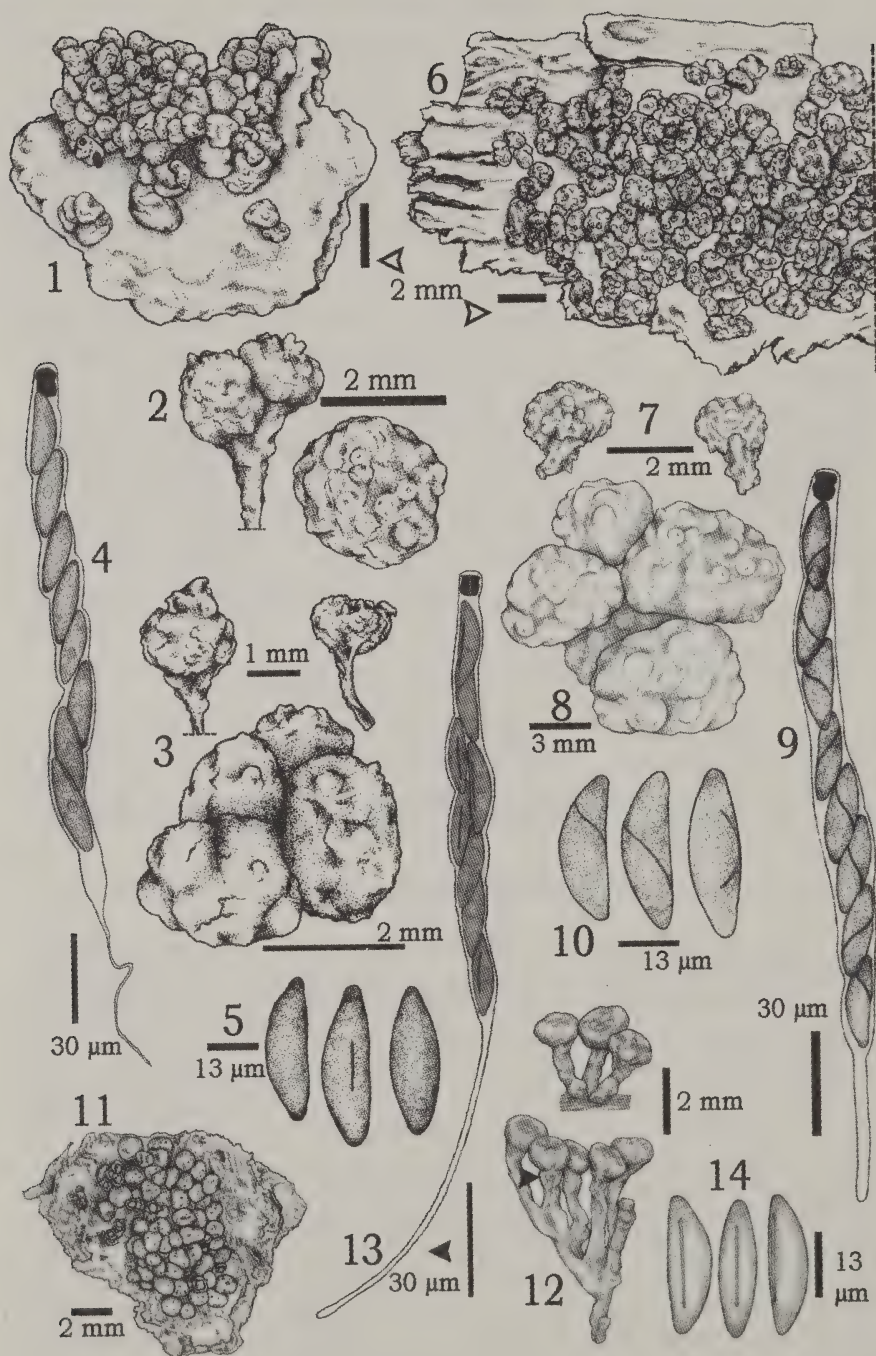
Stromata with convex, turbinate or obconical fertile parts 1-3 mm diam., usually densely aggregated or fused into a small crust, tapering downwards into radiating, infrequently branched, cylindrical stipes, or sessile; surface dull blackish brown, cracked into small scales (corky, reticulate, fragmentary crust); carbonaceous immediately beneath surface; tissue between and beneath perithecia coriaceous, yellowish or brown, becoming dark brown and disintegrating. *Perithecia* spherical, 0.4-0.8 mm, 1-4 per club. *Ostioles* minutely conical (hardly visible among the fragments of the clubs). *Asci* 8-spored, cylindrical, stipitate, fugacious, 246-315 µm total length x 12 µm, spore-bearing parts 168-267 µm long, stipes 36-78 µm long, apical ring IK⁺, urn-shaped, 9-12 x 6.5-8 µm. *Ascospores* brown to dark brown, unicellular, fusoid, inequilateral, with narrowly rounded ends, often pinched, smooth, 35-40.5 (-44) x 10.5-12 (-13) µm, with a straight germ slit shorter than spore length.

It was not possible to obtain a culture after several attempts.

Specimens examined: The holotype **LIL**. Isotype **BAFC**, **BPI**. **Argentina**: Tucumán: Depto. Chicligasta, Parque Provincial El Cochuna, ruta prov. 331, Camping Samay, 1300 m asl., 28-III-95, Catania 381, **BPI**; ibid 14-VI-97, Hladki, 496, 494b **LIL**; ibid 14-VIII-99, Hladki 2314 **LIL**; ibid. 12-XI-99, Hladki 2336 **LIL**.

Substratum: on remains of bark from large semi-rotten trunks of a dicotyledon.

Notes: It is interesting to point out that this new species was only found in the type locality in 1995, 1997 and 1999. The new taxon seems to be close to *K. micropus* (Fr.: Fr.) Sacc. and to *K. clavus* (Fr.: Fr.) Sacc. The lectotype of *K. micropus* (NY!) was also studied. The clubs of *K. micropus* and *K. argentinensis* are similar in size and shape, but the clubs of the latter have a strongly roughened surface and the diagnostic feature of the conical or spine-like processes or umbos on the fertile parts of *K. micropus* is absent. The stalk can be present or not in the Argentine species but, when present, it is cylindrical and generally short, whereas in *K. micropus* it is strap-like. The apical ring of *K. argentinensis* is larger than in *K. micropus* (9-12 x 6.5-8 µm and 7-8 x 5 µm, respectively). Both species have similar ascospores in shape and colour and size but, in this new species, the germ slit is short whereas in *K. micropus* it is almost as long as the total length of the spore. Another difference is the number of perithecia per stroma: in *K. argentinensis* there are many, but in *K. micropus*, generally, there is only one. With respect to *K. clavus*, the main differences are: a) *K. argentinensis* has small clubs (1-3 mm diam.) and a convex and very rugose surface (never plane). Stromata are sessile or with short, cylindrical or subcylindrical, rarely branched stipes. It lacks the dull reddish



brown tomentum at the base of stipes which is generally present in *K. clavus*. b) Perithecia are spherical and smaller in size (0.4-0.8 mm) than *K. clavus*. c) The apical ring (9-12 x 6.5-8 μm) is larger than in *K. clavus*. d) Ascospore size range 35-40.5 (-44) x 10.5-12 (-13) μm is close to the maximum values of the size of the ascospores of *K. clavus*.

K. clavus is very abundant in all the localities where we have collected and no specimen with intermediate features was found. The differences warrant the new species.

Additional material: **Angola:** Welwitsch, on wood, type of *Hypoxylon aggregatum* (= *K. micropus*), **K. Brazil:** Rick, J., on wood, as *Kretzschmaria lichenoides* (= *K. micropus*) **GZU-Petrak** 2084; Sao Paulo, 5.IV.1947, Fogg, H., on wood, as *K. spinifera* (= *K. micropus*) **GZU-Petrak**. **Mexico:** 1895, Smith, C.L., on wood, lectotype of *K. micropus*, **NY**.

***Kretzschmaria clavus* (Fr.: Fr.) Sacc., Syll. Fung. II, p. XXIX, 1883**

(Fig. I: 11-14; Fig. III: 7)

= *Sphaeria clavus* Fr., *Linnaea* 5: 543, 1830; Fr.: Fr., *Syst. Mycol. Index*, p. 162, 1832

For list of synonyms and description see Rogers & Ju (1998)

Cultures were obtained (Cult. Collections LIL 702, 854, 807, 906). Macroscopical features of the colonies are the same as of those given by Rogers & Ju (1998). Coiled hyphae of the mycelium were observed as those described in several cultures of *Xylaria* species (Van der Gucht, 1996). Anamorph was not produced.

Specimens examined: **Argentina:** Buenos Aires: Santa Catalina, 23-IX-1969, Gamundi, Dring & Martínez **BAFC** 50076. *Misiones:* Parque Nacional Cataratas del Iguazú, Camping Ñandú, Reserva, 28-X-1973, Wright, Deschamps & Del Busto M-2426, on the base of a semirotten palm (*Syagrus* sp.) **BAFC** 50077. *Ibid.* Macuco, 23-IX-1984, Job M-3814 **BAFC** 30407. *Tucumán:* Depto. Chicligasta, Parque Provincial El Cochuna, Prov Route 331, Camping Samay, 1300 m asl, 10-XI-89, Hladki 228 **LIL** **BAFC** cult. XXXX; *ibid* 14-VI-97, Hladki 495 **LIL**, *ibid.* 14-X-97, Hladki 529 **LIL**; *ibid.* 23-IV-98, Hladki 756 **LIL**; *ibid* 29-V-98, Hladki 847 **LIL**; *ibid* 15-II-99 Hladki 2159 **LIL**; *ibid* 17-V-99 Hladki 2304 **LIL**; 14-VIII-99 Hladki 2312 **LIL**; *ibid.* 12-XI-99 Hladki 2333 **LIL**. Depto: Lules, Quebrada de Lules, on a pathway next to the camping, 21-III-88, Hladki 159 **LIL**; *ibid.* Prov. Route 380 facing the river, 5-IV-88, Hladki 175

Fig. I. 1-5: *Kretzschmaria argentinensis* 1. Macroscopic morphology of stromata. 2-3. Macroscopic morphology of infrequently branched and unbranched, cylindrical stipes. 4. Ascus with apical ring, I⁺. 5. Ascospores with germ slit. 6-10. *Kretzschmaria sigmoidirima* 6. Macroscopic morphology of stromata densely aggregated or fused into small crust. 7. Macroscopic morphology of cylindrical, irregular and short stipes. 8. Stromatal surface with strongly mammiform ostioles (arrow). 9. Ascus with apical ring, I⁺. 10. Ascospores with sigmoid to spiral germ slit. 11-14: *Kretzschmaria clavus* 11. Macroscopic morphology of stromata. 12. Macroscopic morphology of erect, cylindrical, unbranched stipes. Stipes branches fusonate at the base, radiating from a common centre as small bunches, with "apophysis" (arrow). 13. Ascus with apical ring, I⁺. 14. Ascospores with germ slit.

LIL; Depto. Yerba Buena, Sierra de San Javier, Quebrada de Cainzo, on *Phoebe porphyria* (Griseb.) Lillo, Vervoost, as *K. puiggarii* (Speg.) Sacc. **LIL**; ibid, Río Los Sosas, El Indio, 1200 m asl, 19-VII-1974, Deschamps & Del Busto 2578, on semirodden trunk of *Phoebe porphyria* **BAFC** 50075, ibid, Parque Biológico Sierra de San Javier, Horco Molle, 800 m asl, near University residence, crossing Muerto river, 6-IV-98, Hladki 702 **LIL**, road parallel to dispensary, 14-V-99 Hladki 2286 **LIL**, ibid. 18-VIII-99 Hladki 2317 **LIL**, ibid. 17-XI-99 Hladki 2334 **LIL**; Depto: Monteros, Reserva Provincial La Florida, Prov route. 325, 700 m asl, 3-VII-98, Hladki 883 on trunk of *Phoebe porphyria* **LIL**, ibid. 17-II-99 Hladki 2170 **LIL**, ibid. 11-IV-99 Hladki 2309 **LIL**, ibid 25-VIII-99 Hladki 2325 **LIL**. Depto: Trancas, La Higuera, Cerro Alto de La Totorá, crossing river La Higuera, 1500 m asl, 21-V-99 Hladki 2305 **LIL**, 23-VIII-99 Hladki 2324 **LIL**. Depto: Tafi Viejo, Parque Biológico Sierra de San Javier, road to top of Taficillo near Nina Velardez site, El Balcón, 1300 m asl, 25-II-99 Hladki 2253 **LIL**, 24-V-99 Hladki 2308 **LIL**, 20-VIII-99 Hladki 2319, on semirodden trunk of "Horco cebil" (*Piptadenia macrocarpa*) **LIL**. Depto: Burruyacú, Sierra de Medina, Prov. route 310, Km 31 from Villa Padre Monti, Aguas Negras, Finca Mansilla, 1600 m asl, 30-X-98 Hladki 2001 **LIL**.

Additional material: **Africa:** Lloyd, C.G., as *K. puiggarii* **BPI** 716922 [Lloyd herb. 11995]. **Brazil:** Rio Grande do Sul, I. 1922, Rick, J. 20380, on wood, as *K. divergens* **BPI** 594482; Mato Grosso, Serra da Chapada, Buriti, 6.IV.1894, Malme G.O., on wood, **BPI** 594483. isotype of *K. divergens*, S holotype; Rio Grande do Sul, Sao Leopoldo, 1906, Rick, J., on wood, as *K. divergens* **BPI** 594484; Apiaty, Sao Paulo, Puiggari J., on wood, ex Spegazzini **BPI** 716921 [Lloyd Herb. 12004], type of *K. puiggarii* **LPS** 27236; Itatiaia, 19.X.1969, Dring, D.M. 117, on wood, as *K. clavus* **K** 62682. **Nicaragua:** Castillo Viejo, Río San Juan, II-III.1893, Smith, C.L., on wood, **BPI** 716923 [Lloyd herb. 11993], **BPI** 716925 [Lloyd herb. 11995], **GZU**-Petrak 2089 [ex Lloyd herb] type of *K. pusilla*. **Zaire** "Belgian Congo", Vanderyst, H., on wood, as *K. pusilla* by Lloyd, C.G. **BPI** 716924 [Lloyd herb. 12813].

Substratum: Stromata are generally on big, fallen, rotten trunks of dicotyledon covered by mosses; however a note in the collection **BAFC** 50 077 reads "on monocotyledon". Most of the time, because of the condition of the substratum, it was difficult to identify the host. Some specimens were found on living trees of *Phoebe porphyria* (Griseb.) Lillo, *Piptadenia excelsa* (Horco cebil) (Griseb.) Lillo, as well as on semi-rotten palm *Arecastrum* sp., **BAFC** 50077).

In the "Fiscal Reserve Parque La Florida" there is a large number of living trees attacked by this species and stumps are so completely covered by black stromata that they seem to be burnt. It is worth mentioning that in a pure forest of *Podocarpus parlatorei* Pilg. it is not present on this tree although it occurs on other hosts in the same area.

Geographic distribution: Brazil, Ecuador, French Guiana, Grenada, Mauritius, Nicaragua, Papua New Guinea, Paraguay, Puerto Rico, Uganda, U.S.A., Zaire (Rogers & Ju 1998), Mexico (San Martín & Rogers, 1993), Venezuela (Dennis, 1970), Guyana, St. Vincent, Colombia, Cuba (Dennis, 1957), Bolivia (Dennis, 1958).

Notes: The Argentine specimens coincide with the description given by Rogers & Ju. (1998) except for: a) Dull reddish brown tomentum at the base of the stipe in fresh and young specimens that is lacking in old ones. b) A small eccentric sterile umbo in some specimens (LIL 847, 703, 906, 883, 495, 529, 2170, 2253, 2317, BAFC 50077) and in some clubs, as was also observed by San Martín & Rogers (1993) in Mexican specimens. It is worth saying that in the original description of this species the umbo is not mentioned and according to Rogers & Ju (1998) is an important character which they use in the key to separate species into two groups. c) Thick stipe just at the point of union to the club, which we call apophysis. d) Asci with longer pedicels. e) rather shorter ascospores.

The specimens show large morphological variation, sometimes appearing as loose, light to dark brown crusts of aggregations of clubs, poorly branched, with erect stipes, and with the appearance a nail (identical to Dennis (1957) 'drawing of this species), but at other times they appear as a large, compact crust of fused clubs with a smooth, black, plane surface identical to Dennis ' drawing (1957) to illustrate *K. coenopus* (Fr.:Fr.) Sacc., on highly branched stipes, sometimes erect, sometimes parallel to the substratum but not losing their individuality nor their cylindric shape.

According to Rogers & Ju (1998) *Kretzschmaria clavus* is undoubtedly a pathogen of roots and/or butts. It was reported by Ko *et al.* (1977) to cause root rot of *Macadamia integrifolia* Maiden & Betcher, the most serious disease of this tree in Hawaii. It is very common to observe large fallen trunks with almost 70 % of their surface covered by *K. clavus*, in addition to effuse *Kretzschmaria* ustulinoid type stromata such as *K. deusta* (Hoffm.: Fr.) P. Martin, or *K. sandvicensis* (Reichardt) J. D. Rogers & Y.-M.- Ju..

Although the stromata persist during the different seasons the best time to find young grey coloured stromata with the anamorph in the Tucumán "Yungas", is between the end of spring and the beginning of summer. It is very important to take into account the presence of this pathogenic species because of its destructive effects (Ko *et al.* 1977, 1982, 1986).

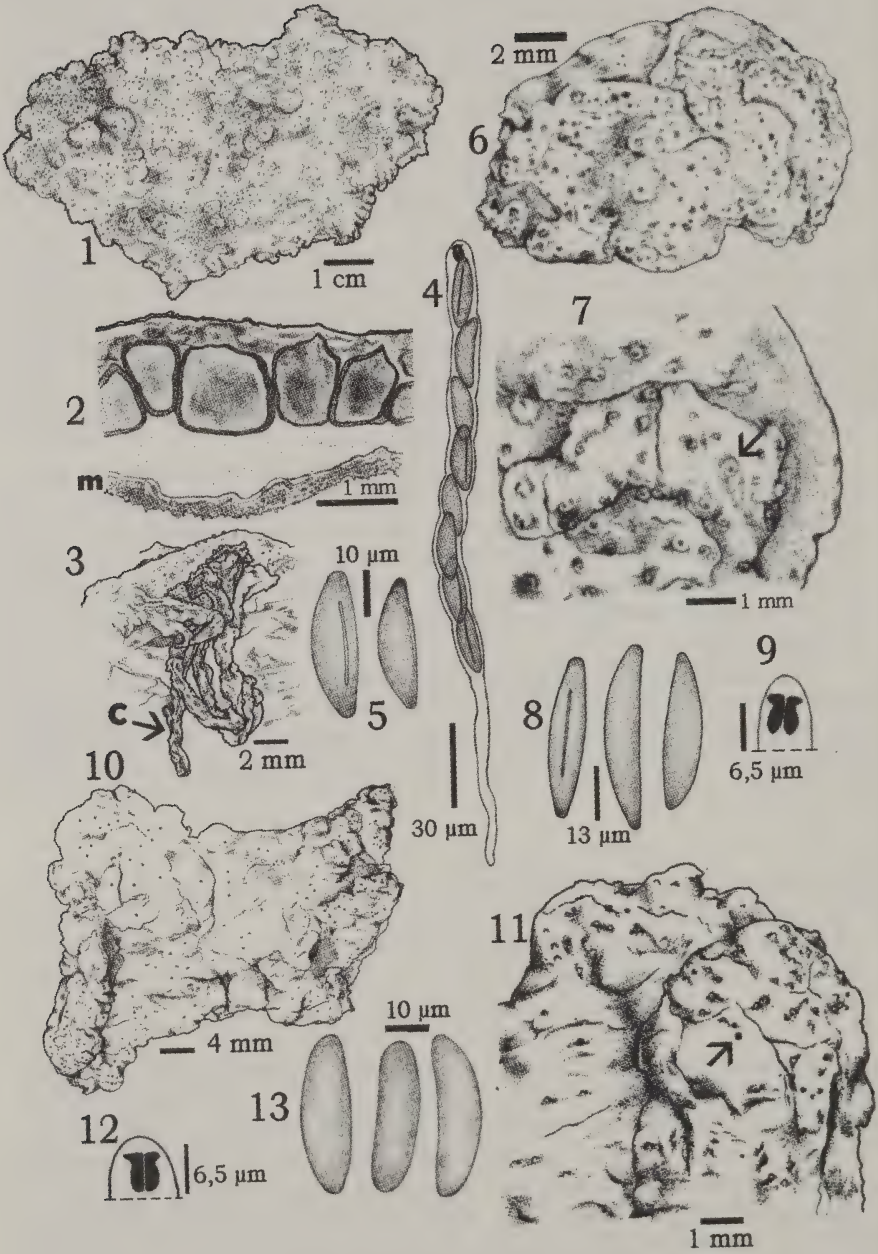
Kretzschmaria deusta (Hoffm.: Fr.) P. Martin, J. S. African Bot. 36: 80. 1970

(Fig. II: 1-5; Fig. III: 5)

≡ *Sphaeria deusta* Hoffm., Veg. Crypt. I, p: 3. 1787; Hoffm.: Fr., Syst. Mycol. II, p. 345. 1823; non Wahlenberg, 1812.

For list of synonyms see Rogers & Ju (1998)

Stromata pulvinate to effused pulvinate, rarely orbicular, discrete, densely aggregated or fused, 10-28 x 1-4 mm, attached to substrate with narrow connectives, usually with crenate, sloped margins; surface dark brown to blackish brown, especially towards the margin of the stromata, often with reticulate major cracks; carbonaceous immediately beneath the surface; tissue between and beneath perithecia coriaceous to woody, white to gray, becoming dark brown and disintegrating; with a hairy brown coppery mat in the abaxial face of the stroma. **Perithecia** obovoid to tubular, 0.4-1.3 x 0.6-1.4 mm. **Ostioles** conic papillate, minute, darker than the surface of the stroma. **Asci** 246-276 µm total length x 10-14 µm, spore-bearing parts 171-189 µm long, stipes 66-



114 μm long, apical ring IK⁺, urn-shaped, 4-5 x 4-5 μm . *Ascospores* brown to dark brown, unicellular, fusoid- inequilateral, with acute ends sometimes pinched, smooth, 26-31 (-34) x 6.5-8 (-9) μm , with a straight germ slit less than 2/3 of spore length.

Cultures were obtained (Cult. Collections LIL 2287, 2301, 2306). The features of the colonies are the same as of those given by Jong and Rogers (1972) and Petrini and Müller (1986) except for anamorph was not produced.

Specimens examined: **Argentina:** Tucumán: Depto. Chicligasta, Parque Provincial El Cochuna, prov. route 331, Camping Samay, 1300 m asl., 29-V-98, Hladki 838 **LIL**; ibid 17-V-99, Hladki 2301 **LIL**; ibid. 12-XI-99, Hladki 2338 **LIL**; Depto. Yerba Buena, Parque Biológico Sierra de San Javier, Horco Molle, 800 m asl, near University residence, crossing Muerto river, 6-IV-98, Hladki 714 **LIL**; ibid road parallel to dispensary, 18-VIII-99 Hladki 2316 **LIL**, ibid. 17-XI-99 Hladki 2341 **LIL**; Depto: Monteros, Reserva Provincial La Florida, ruta prov. 325, 700 m asl, 17-II-99 Hladki 2202 **LIL**, ibid. 11-VI-99 Hladki 2310 **LIL**, ibid 25-VIII-99 Hladki 2327 **LIL**, ibid. 24-XI-99 Hladki 2344 **LIL**. Depto: Trancas, La Higuera, Cerro Alto de La Totorá, crossing river La Higuera, 1500 m asl, 19-II-99 Hladki 2216 **LIL**, ibid. 21-V-99 Hladki 2306 **LIL**, 23-VIII-99 Hladki 2322 **LIL**, ibid. 15-XI-99 Hladki 2339 **LIL**; Depto: Burruyacu, Sierra de Medina, prov route 310, Km 31 from Villa Padre Monti, Aguas Negras, Finca Mansilla, 1600 m asl, 19-V-99 Hladki 2302 **LIL**, on living *Podocarpus parlatorei* Pilg.. Depto: Tafi Viejo, Parque Biológico Sierra de San Javier, road to the top of Tafiello near Nina Velardez site, El Balcón, 1300 m asl, 1-XII-99 Hladki 2345 **LIL**.

Additional material: **Cuba:** Central Trinidad, Iznaga, Prov. Santa Clara, 21.XI.1924, Weir, J. R., on wood of *Cailliea glomerata*, as *Ustulina zonata* by Weir, J. R. BPI 586819; GZU-Petrak 1075. **Czech Republic:** Mähren (now Moravia), Olspitz bei Mähr.- Weißkirchen, X.1931, Petrak, F., Mycoth. General. 1886, on wood, as *Ustulina deusta* by Petrak, F. WSP 19263. **French Guiana:** Säul, Circuit Grand Fosse, elev. 300-350 m, 10.II.1986, Samuels, G.J. 3633, bark NY. **Germany:** Bavaria, Mittelfranken, Kr. Hersbruck, Kukensborg, 23.IX.1946, Starcs, K. 2732, on wood of *Fagus silvatica*, as *Ustulina vulgaris* WSP 15763. **Mexico:** José María Morales Municipality, Quintana Roo, 6.XI.1986, San Martín 733, on living Citrus tree ITCV. **Puerto Rico:** Mayaguez, Earle, F. S. 247, on wood, as *Ustulina zonata* by Diehl, W. W.

Fig. II. 1-5 *Kretzschmaria deusta*. 1. Macroscopic morphology of stromata. 2. Longitudinal sections of a stroma with a hairy brown coppery mat in abaxial face (m). 3. Stromata attached to substrate with narrow connectives (c). 4 Ascus with apical ring, I⁺. 5. Ascospores with germ slit. 6-9. *Kretzschmaria pavimentosa* 6. Macroscopic morphology of a stroma. 7. Stromatal surface with ostioles coarsely papillate, conical (arrow). 8. Ascospores with germ slit. 9. Apical ring I⁺. 10-13. *Kretzschmaria sandvicensis* 10. Macroscopic morphology of a stroma. 11. Stromatal surface with ostioles papillate ostiolar openings (arrow). 12. Apical ring I⁺. 13. Ascospores with germ slit.

BPI 587147. U.S.A. : Kentucky, Fort Thomas, IV.1912, Weir, J. R. 2716, on wood of *Fagus americana*, as *Ustulina linearis* **BPI 587139;** New Jersey, 31.VII.1920, Sterling, E. B., on wood **GZU- Petrak 2023**, isotype of *Hypoxyton magnosporum*; Ohio, Hamilton Co., Cincinnati, Stanberry Park, 2.X.1956, Cooke, W.B. 30434, on wood of *Fagus grandifolia*, as *Ustulina vulgaris* **WSP 45000. U.K.:** Scotland, Midlothian, South Queensferry, 16.X.1965, Watling, R. 926, on wood of *Fagus sylvatica*, as *Ustulina deusta* **E 00046128;** Cooke, M. C., Fungi Britannici Exsiccati, Ed. II, no. 465, on wood, as *Ustulina vulgaris* **E 00046132;** ex herb. Cooke, on wood, as *Ustulina vulgaris* **E 00046133;** Hants, Lyndhurst, X. 1879, Baker, J. G., beech on wood, as *Ustulina vulgaris* **E 00046129.**

Substratum: Specimens were generally found on large branches or fallen decaying trunks of dicotyledon, with bark or decorticated, along with fern rhizomes and mosses. They were also detected at the base of stumps along with of *K. clavus*. Only once they were found on a living tree of *Podocarpus parlatorei* Pilg.

Geographic distribution: Czech Republic, Germany, U.K., U.S.A. Mexico.

According to Rogers & Ju (1998) this species is most commonly encountered in the North Temperate Zone. San Martín & Lavin (1997) has reported it from Mexico.

Notes: Rogers & Ju (1998) point out that there are reports of this species from tropical and subtropical zones, but they believe these records are misidentifications and correspond to the tropical species *K. pavimentosa* (Ces.) P. Martin, *K. sandvicensis* (Reichardt) J. D. Rogers & Y.-M. Ju and *K. zonata* (Lév.) P. Martin. However, *K. deusta* is present in Tucumán province, "The Yungas Phytogeographic Province", a subtropical zone of the Amazonic Domain, Neotropical Region, following Cabrera, 1971 and Hueck, 1978. Its identification was confirmed by examination of the holotypes of *K. pavimentosa* and *K. sandvicensis* and specimens determined as *K. zonata* by Rogers & Ju (1998).

K. deusta is the first record from Argentina. These Argentine specimens coincide with their description except for: a) Presence of a hairy brown coppery mat in the reverse of fresh stromata (**LIL 2202**). b) Some specimens have effuse-pulvinate stromata without stipes or with very long, strap-like (**LIL 2327**) stipes immersed in cracks of the wood. This was also observed by Martín (1970).

K. deusta and *K. sandvicensis* are similar. The main differences between them are the features and size of the ascospores: in *K. deusta* they are: 26-31 (32.5) x 6.5-8 (-9) µm, with narrow round ends and with a short, straight germ slit whereas, in *K. sandvicensis* they are 32.5-40.5 x 9.1-12 µm, with broadly round ends and with a long germ slit occupying 80 % of the total length of the ascospore. It is very important to state that Schwarze *et al.* (1995) have shown soft-rot cavity formation in the S₂ layer of secondary cell walls caused by *K. deusta*.

Ecological observations: The best period for collecting is between late summer and autumn and at the end of spring and early the summer anamorphic stromata are found with a grayish surface due to mass of conidia.

***Kretzschmaria pavimentosa* (Ces.) P. Martin, J. S. African Bot. 42: 74. 1976**

(Fig. II: 6-9; Fig. III: 4)

≡ *Hypoxylon pavimentosum* Ces., Atti Accad. Sci. Fis. 8: 18. 1879

For list of synonyms see Rogers & Ju (1998)

Stromata discoid, restricted-pulvinate, or effused pulvinate, discrete or densely aggregated, 8-30 x 2-3 mm, usually with crenate, steep margins; surface greyish brown, smooth or with major cracks; carbonaceous immediately beneath the surface; tissue between and beneath perithecia coriaceous to woody, white to gray, becoming dark brown and disintegrating. In the abaxial face of the stromata a coppery brown hairy mat is present. *Perithecia* obovoid to obclavate, 0.8-1.3 x 1.1-1.2 mm. *Ostioles* papillate, minute, dark brown. *Asci* 264-288 µm total length x 10-12 µm broad, spore-bearing parts 150-170 µm long, stipes 99-120 µm long, apical ring IK⁺, urn-shaped, 5-6.5 x 4-5 µm. *Ascospores* brown to dark brown, unicellular, fusoid-inequilateral, with acute ends sometimes pinched, smooth, 42-55 x (-8) 9-13 µm, with a straight germ slit shorter than the spore length (19.5-22 µm length).

Cultures were obtained (Cult. Collections LIL 514, 515). The features of the colonies are the same as of those given by Rogers & Ju (1998). Anamorph was not produced.

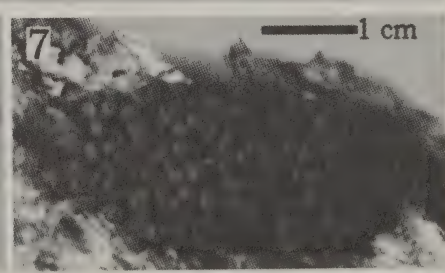
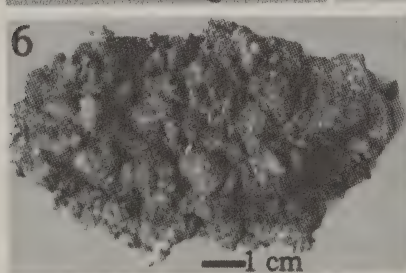
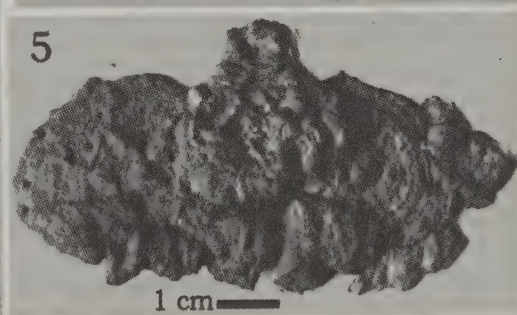
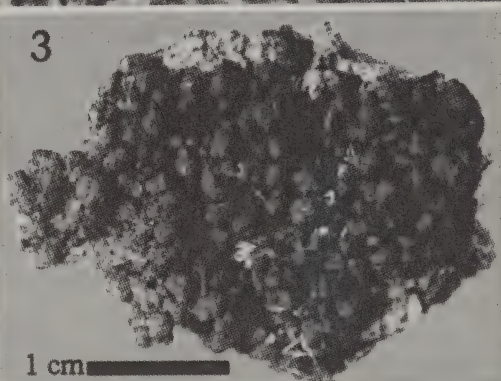
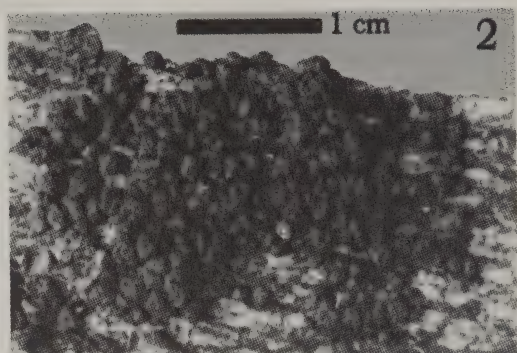
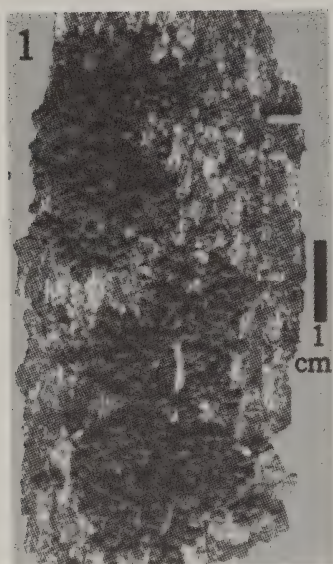
Specimens examined: **Argentina**: Tucumán: Depto. Chicligasta, Parque Provincial El Cochuna, prov. route 331, Camping Samay, 1300 m asl., 14-X-97, Hladki 514 LIL.

Additional materials: **Brazil**: Ule, H. E., Holotype of *Kretzschmaria bulgarioides* S; Ule, H. on wood Pará, Municipio Oriximiná, Río Trombetas, 19.VI.80, Dunn P. 80PHD-16 NY. **French Guiana**: Piste de Saint-Elie, Km 16 on road between Sinnamary and St. Elie, ECEREX, ORSTOM research area, II-III. 1986, Samuels, G. J. 4037, bark NY; Paul Isnard Area, ca. 150 Km S of St. Laurent du Moroni, Citron, Mt. Decou Decou, 11, 12.III.1986, Samuels, G.J. & Searwar, P. 4237 & 4246, bark of liana NY; Upper Marouini River: between Roche Koutou and unnamed granitic, 19,20-VIII-87, Samuels, G.J. et al. 5920 NY **Guyana**: Cuyuni-Mazaruni Region, Mazaruni Subregion, along Koatse R., II, III-87, Samuels, G. J. et al. 4927, on log NY. **Malaysia**: Borneo, Sarawak, Beccari, O. 206, on wood K 52691. lectotype of *Kretzschmaria pavimentosum*. **Mexico**: Chiapas State, Ocosingo Municipality, Boca de Chajul, 29.V.1988, San Martín, F. 838 ITCV. **Puerto Rico**: Mayaguez, Las Marias Road, Earle, F. S. 246, on rotten stump, as *Ustulina zonata* by Diehl, W. W. BPI 587146. **Sudafrica**: Krysna, Garden of Eden, I. 1958, as *Ustulina deusta*, Martín, P. 52 BAFC.

Substratum: on decaying trunk of a dicotyledon.

Geographic distribution: Brazil, Ecuador, French Guiana, Guyana, Grenada, Honduras, Malaysia, Mexico, New Zealand, Puerto Rico, Taiwan (Rogers & Ju, 1998); Dennis, 1970).

This fungus is one of the most frequently encountered *Kretzschmaria* species in the tropics and subtropics (Rogers & Ju, 1998).



Notes: Our material coincides with the description given by Rogers & Ju (1998) except for: a) thinner and more sloped margins and b) the presence of a hairy mat in the inferior part of the stromata.

Ecological observations: It was only found once in the en Río Cochuna area in October 1997 although almost all the province was explored in the different seasons during several years.

Kretzschmaria sandvicensis (Reichardt) J. D. Rogers & Y.-M. Ju. Mycotaxon LXVIII: 366. 1998

(Fig. II: 10-13; Fig. III: 6)

≡ *Hypoxydon sandvicense* Reichardt, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. I, 75: 6. 1877

For list of synonyms see Rogers & Ju (1998)

Stromata pulvinate to effused pulvinate, discrete, orbicular to densely aggregated or fused, 18-85 x 1-4 mm, attached to substrate with narrow connectives, usually with crenate, sloped margins; surface dark brown to blackish brown specially at the margins, often with reticulate major cracks; carbonaceous immediately beneath the surface; tissue between and beneath perithecia coriaceous to woody, white to gray, becoming dark brown and disintegrating; in the inferior face a hairy cuprous brown mat is present. *Perithecia* rectangular to ovoid, 0.6-1.2 x 0.4-0.8 mm. *Ostioles* finely papillate. *Asci* 261-330 µm total length x 10-12 µm broad, spore-bearing parts 141-189 µm long, stipes 120-180 µm long, apical ring IK⁺, urn-shaped, 5-6.5 x 5-6.5 µm. *Ascospores* dark brown, unicellular, fusoid to ellipsoid, inequilateral, with broadly rounded ends, smooth, 32.5-40.5 x 9-12 µm, with a straight germ slit slightly shorter than the spore length (80 % of the total length of the ascospore).

Cultures were obtained (Cult. Collections LIL 2311, 2106). The features of the colonies are the same as of those given by Rogers & Ju (1998). Anamorph was not produced.

Specimens examined: **Argentina:** Tucumán: Depto. Chicligasta, Parque Provincial El Cochuna, prov. route 331, Camping Samay, 1300 m asl., 10-XI-89, Hladki 234 **BAFC**; ibid 15-II-99 Hladki 2160 **LIL**; 14-VIII-99 Hladki 2311 **LIL**; ibid. 12-XI-99 Hladki 2325 **LIL**; Depto: Tañi Viejo, Parque Biológico Sierra de San Javier, road to the top of Taficillo near of Nina Velardez site, El Balcón, 1300 m asl, 20-VIII-99 Hladki 2320 **LIL**.

Additional materials: **Colombia:** near Tumaco, XII. 1940, Skutch & Stryker, Stakman 245, on wood, as *Ustulina zonata* by Diehl, W.W. **BPI** 587044. **French**

Fig. III. General Aspects: 1-2. *Kretzschmaria sigmoidirima* (LIL 715). 3 *Kretzschmaria argentinensis* (LIL 494b). 4 *Kretzschmaria pavimentosa* (LIL 521). 5 *Kretzschmaria deusta* (LIL 2327). 6 *Kretzschmaria sandvicensis*. (LIL 2160). 7 *Kretzschmaria clavus* (LIL 2309).

Guiana: Piste de Saint-Elie, Km 16 on road between Sinnamary and St. Elie, ECEREX, ORSTOM research area, II-III.1986, Samuels, G. J. 3861, on bark **NY**. **India:** Bombay, 1882, Carter, H. J., on wood, **K** 52689, holotype of *Kretzschmaria tessulata*. **Java:** Tjibodas, 1907-1908, Höhnelt, F., Weese's Eumycetes Selecti Exs. 431, on rotten wood, as *U. zonata* **BPI** 587148. **U.S.A.:** Hawaii, Wailuku, 1868-71, Wawra 1831&1832, on corticated wood **W**1831, **W**1832: holotype of *Hypoxylon sandvicense*.

Substratum: on semi-rotten trunk of a dicotyledon.

Geographic distribution: Colombia, French Guiana, Guyana, India, Mexico, New Caledonia, Papua New Guinea, Philippines, Puerto Rico (Rogers & Ju, 1998); Dennis, 1970). This fungus is one of the most frequently encountered *Kretzschmaria* species in the tropics and subtropics (Rogers & Ju, 1998).

Notes: see notes on *K. deusta*.

Kretzschmaria sigmoidirima A.I. Hladki & A.I. Romero, sp. nov.

(Fig. I: 6-10; Fig. III: 1-2)

Etym.: sigmoid= curved like the letter S, *rima* = slit

A *Kretzschmaria curvirima* differt in ascosporis ((26)30-32.5 x (8-)9-10.5 µm) dimensionis, et in annulo apicali 8 x 5-6.5 µm. Holotypus: **LIL**. Argentina: Tucumán: Depto. Yerba Buena, Parque Biológico Sierra de San Javier, Horco Molle, 800 m asl, ad viam prope dispensarium, 17-XI-99, Hladki 2340. Isotypus **BAFC** 50.694 et **BPI** 747.564.

Stromata with convex or flattened fertile parts 1.5-3.5 mm diam., usually containing one or two perithecia, densely aggregated or fused into a small crusts, frequently sessile or tapering downwards into cylindrical, irregular and short stipes, surface dull brown, irregular by cracked into diminute scales; carbonaceous immediately beneath the surface; tissue between and beneath perithecia coriaceous, yellowish or brown, becoming dark brown and disintegrating. *Perithecia* ovoid to spherical, 0.5-0.7 x 0.5-0.9 mm. *Ostioles* strongly mammiform papillate. *Asci* eight-spored, cylindrical, stipitate, fugacious, 195-297 µm x 10-12 µm, spore-bearing parts 165-207 µm long, stipes 80-91 µm long, apical ring IK⁺, urn-shaped, 8 x 5-6.5 µm. *Ascospores* dark brown, unicellular, ellipsoid or fusoid, inequilateral, with narrowly rounded ends, smooth, (26-) 30-32.5 x (8-) 9-10.5 µm, with a sigmoid to spiral germ slit slightly shorter than the spore length.

Unfortunately, several attempts to culture it proved unsuccessful.

Specimens examined: Holotype: **LIL**. Isotype **BAFC** 50694, **BPI** 747564. Same data as holotype, 06-IV-98, Hladki 715.

Additional material: **Guyana:** Cuyuni-Mazaruni Subregion, vic. Chinoweing Village, elev. 650-750m, 20-23.II.1987, Leg.: Samuels, G.J. et al. 4642^a, Det.: Rogers, on wood, holotype of *K. curvirima* J.D. Rogers & Y.-M. Ju, **NY**. Isotype of *K.*

curvirima WSP 69722.

Substratum: on remains of bark from semi-rotten large trunks of a dicotyledon.

Notes: It is worth mentioning that although almost all the province was explored, this new taxon was only found in this locality in autumn and spring.

It was compared with the holotype (NY!) of *K. curvirima* Rogers & Ju (1998) since this was the only species recorded with a sigmoid germ slit. This feature is almost the same in both species but they differ because: a) *K. curvirima* has conic spines on almost all the clubs, whereas in *K. sigmoidrima* they are absent b) the perithecia in *K. sigmoidrima* are ovoid to spherical and c) perithecia, apical apparatus and ascospores are smaller than in *K. curvirima*

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Specially the authors thank to Dr. Jorge E. Wright for reading this manuscript and to Dra. Graciela Kohen for the Latin diagnosis, as well as to Dr. Rogers and Dr. San Martín for their valuable comments.

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ONLINE RESOURCES FOR FUNGAL TAXONOMY & NOMENCLATURE: Web design

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Now that it's more than just trendy to have a web page, here are some thoughts on developing a site, and one the factors that impact your site's usability. Basic web pages are written in hypertext mark-up language (HTML). They consist simply of a text file with embedded instructions called tags. The tags that tell a browser (Netscape or Explorer) how to display the text and where image files are to be inserted.

Generating HTML

Any text editor or word processor can be used to create web pages, but a dedicated HTML editor will save you having to learn HTML tags. Macromedia Dreamweaver and Microsoft Frontpage are excellent examples of this genre; various freeware and shareware editors are also available. An excellent way to learn HTML tricks is to peek at the code behind your favorite pages by selecting "View source" from your browser's menus. Like the ICBN, HTML is an evolving standard. The WC3 site below is the official guide to current specifications.

Dreamweaver

<http://macromedia.com/software/dreamweaver/>

Frontpage

<http://www.microsoft.com/frontpage/>

Virtual Library of WWW Development

<http://www.stars.com/Vlib/>

Beginner's Guide to HTML

<http://archive.ncsa.uiuc.edu/General/Internet/WWW/HTMLPrimer.html>

Bare Bones Guide to HTML (in many languages)

<http://werbach.com/barebones/>

WC3 HTML standards

<http://www.w3.org/MarkUp/>

Be kind to your users

Once you've figured out how to generate the code, it's tempting to install lots of fancy features like blinking alerts, animated arrows, your musical compositions, and dizzying background images. Please try to resist.

A first-time user *might* be willing to read a lot of text before encountering the information they're looking for. Repeat users want to get to the "meat" of things quickly, so give them several ways to navigate your site. Provide an abbreviated Table of Contents at the top and bottom of pages, or use a sidebar with a site map. Put your search box in a left-hand, non-scrolling frame so it's always handy. Don't make users return to the home page to get to a different part of the site. A nice short page that is to the point and provides a clear map of the rest of your site makes an excellent home page.

Your users have different monitor sizes, and browsers that deal with newer tags in different ways. Try to preview your site on several machines of varying vintage. For background and text colors, stick with “web safe” colors—others are rendered approximately on some computers through dithering, and appear as a distracting sprinkling of colored snow. Consider, too, that some users are viewing your page from home using a slow modem, and might not appreciate all those gratuitously animated images you made one night after drinking too much coffee. Most graphics programs (and the website below) will help you save an image in a reduced size optimized for the web, which can save long load times without sacrificing image quality.

Web-safe colors from Lynda.com

<http://www.lynda.com/hex.html>

Optimize It Here

<http://optimizeithere.com/>

Site indexing

The old-fashioned method of indexing is to provide a table of contents. As your site begins to grow you will regret this, as it requires you to personally keep track of the relationships amongst all your pages. Computers are better at this. You might use a database such as Access or Filemaker to allow highly-customizable searches—Oracle represents the pinnacle of achievement here. Alternatively, Javascripts embedded in your pages can search your site when run through your users’ browsers (transferring the load from your server to their personal computers). Remote search services are run by companies like Webinator that “crawl” your site and create an index on their own server. This method releases you from having to learn how to program a search tool, and is extremely useful for those who maintain many pages but aren’t interested in becoming a web server geek. These services also reduce your control—the remote index may not be updated as frequently as you might like, or you might be obliged to display another company’s advertisement on your site.

Search Tools

<http://www.searchtools.com/>

Cut and Paste Javascript

<http://www.infohiway.com/javascript/>

Webinator Site Search

<http://www.thunderstone.com/webinator/>

Let others know about your site

Many of the major search engines will find your site whether you want them to or not. When your site is brand new, you can give them a head start by submitting your site’s address to a few major search engines, including the WWW VL: Mycology. Also try the MSA Bulletin board and mailing groups related to your topic.

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VOLUME SEVENTY-FOUR

Page 121, line 20, and page 128, last line	for <i>balanae</i>	read <i>balaenae</i>
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VOLUME SEVENTY-EIGHT

Cover page 2, line 5	for <i>reophylla</i>	read <i>rheophyllus</i>
Page iv, line 1	for <i>reophylla</i>	read <i>rheophyllus</i>
Page 185, line 23	for <i>Bat. And Farr</i>	read <i>Bat. and Farr</i>
Page 185, line 25	for <i>types and D. australiense</i>	read <i>types, and D. australiense</i>
Page 185, line 26	for <i>Bat. D. gauntii</i>	read <i>Bat., D. gauntii</i>
Page 185, line 27	for <i>Hughes, D. subramaniani</i>	read <i>Hughes, and D. subramaniani</i>
Page 185, line 30	for <i>have not a sporodochial</i>	read <i>lack a sporodochial</i>
Page 186, line 44	for <i>conidium is</i>	read <i>conidia are</i>
Page 186, line 45	for <i>similar with</i>	read <i>similar to</i>
Page 187, line 1	for <i>conidia</i>	read <i>conidial</i>
Page 187, line 3	for <i>also its</i>	read <i>also conidial</i>
Page 187, line 5	for <i>Detail</i>	read <i>Details</i>
Page 187, line 6	for <i>Conidium</i>	read <i>Conidia</i>
Page 188, line 2	for <i>Detail of the conidium</i>	read <i>Details of conidia</i>
Page 259, line 2	for <i>reophylla</i>	read <i>rheophyllus</i>
Page 262, line 6	for <i>reophylla</i>	read <i>rheophyllus</i>
Page 354, line 26	for <i>Klotczh</i>	read <i>Klotzsch</i>

VOLUME SEVENTY-NINE

Page 76, line 6, page 77, line 6, and page 78, line 6	for	<i>[Discostroma] tricellular</i>	read	<i>tricellulare</i>
Page 96, line 19	for	<i>Scleropsora</i>	read	<i>Sclerospora</i>
Page 177, line 11	for	<i>amonía</i>	read	<i>ammonia</i>
Page 206, line 40	for	<i>restrict</i>	read	<i>restricted</i>
Page 207, line 25	for	<i>collected few times in the neotropical</i>	read	<i>collected a few times in neotropical</i>
Page 208, line 15	for	<i>taxon to the</i>	read	<i>taxon in the</i>
Page 211, line 16	for	<i>the suggests</i>	read	<i>his suggestions</i>
Page 308, line 5	for	<i>Dxion</i>	read	<i>Dixon</i>
Page 310, line 17	for	<i>CAUDATAS</i>	read	<i>CAUDATUS</i>
Page 310, line 26	for	<i>discomycetes</i>	read	<i>discomycete</i>
Page 311, line 34	for	<i>ascospores's</i>	read	<i>ascospore</i>
Page 319, lines 1, 10	for	<i>[Thelotrema] heterospora</i>	read	<i>heterosporum</i>
Page 340-358	for	<i>San Martín</i>	read	<i>F. San Martín</i>
Page 340-358	for	<i>Lavín</i>	read	<i>P. Lavín</i>
Page 439, line 35, page 441, line 20, page 442, line 20, page 444, line 18, and page 445, line 5	for	<i>[Cladonia] symphicarpia</i>	read	<i>symphicarpa</i>
Page 469, line 21	for	<i>[Phellinus] apihaymus</i>	read	<i>apiayahynus</i>
Page 471, line 15	for	<i>Phellinus</i>	read	<i>Phellinus</i>
Page 495, line 8	for	<i>[K.] sigmoidirima</i>	read	<i>sigmoidirima</i>

Reviewers, Volume Seventy-Nine

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

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Edited by Richard P. Korf, with a foreword by Teng's daughter, Rosaline Z. Deng.
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Mycologia 90: 1091-1092, 1998.

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"The publication of Teng's work now gives taxonomists easy access to the contributions of this remarkable scientist without having to undertake a fastidious searching in libraries." *Sydowia* 48: 277-278. 1997.

"The book is important for any researcher interested in the systematic relationships, diversity, and distribution of fungi on a global scale." - *New Zealand Journal of Botany* 35: 265-266. 1977.

"An extensive index to all taxa ... makes this book readily accessible to the user. It should be present in every public and private mycological library." - *Persoonia* 16: 424. 1997.

The mycological flora of the Ficuzza Wood - Rocca Busambra Territory (North Sicily, Italy), by G. Venturella, A. Saitta, S. La Rocca, & S. Onofri. Mycotaxon, Ltd. 2001. Softbound, 68 pp., illustrated, 21 x 29.7 cm. US\$30, or 66,000 Italian Lira, or 35 Euro. (Please **order direct** from Società Editrice ISPE Archimede s.r.l., Via Domenico Trentacoste 34, 90100 Palermo, Italy, email: ispearchimede@katamail.com, tel. +39091302039, fax +39091304551.) ISBN 0-930854-11-0.

The Ficuzza Wood - Rocca Busambra Natural Reserve is considered one of the most interesting areas in Sicily. 669 Basidiomycetes and 72 Ascomycetes are listed together with their habitat, substrate, fructification period, cartographic reference, and status.

A check-list of the mycological flora of Madonie Park (North Sicily), edited by Giuseppe Venturella, Alessandro Saitta, & Salvatore La Rocca. Mycotaxon, Ltd. 2000. Softbound, 246 pp., illustrated, 16.5 x 23.54 cm, 80,000 Italian Lira. (Please **order direct** from Ente Parco della Madonie, Via Paolo Agliata 16, 90027 Petralia Scottana (Palermo), Italy, email: epm@abies.it, tel. +39 0921 68401, fax: +39 0921 680478. ISBN 0-930845-10-2.

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